DWR 224

State of California
The Resources Agency
Department of Water Resources

INTERAGENCY
DELTA HEALTH ASPECTS MONITORING PROGRAM

PROJECT REPORT

Central District

May 1985

Gordon K. Van Vleck	George Deukmejian	David N. Kennedy
Secretary for Resources	Governor	Director
The Resources	State of	Department of
Agency	California	Water Resources

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In September 1982, the Department of Water Resources formed a panel of scientists to evaluate human health aspects of water supplies taken from the Sacramento-San Joaquin Delta. In December of that year, the findinge of the panel were published. The scientific panel found that adequately treated water supplies taken from the Delta were meeting current drinking water criteria. However, the panel observed a lack of data on some constituents of concern to public health; among these were asbestos, sodium, pesticides, and other organic pollutants. Accordingly , the panel recommended a program of data collection to further evaluate health aspects of Delta water supplies and water quality changes that might result from modification of water transfers through the Delta.

Acting on the panel recommendation, the Department implemented the Interagency Delta Health Aspects Monitoring Program. The program was initially established as an lb-month effort to collect data on pertinent health-related water quality constituents in Delta water supplies. Only constituents that are not removed or are extremely difficult to remove using standard treatment processes are being addressed in this study. Biological agents such as viruses, bacteria, and others that can be effectively removed or rendered harmless in the water treatment process are not evaluated.

This report documents program findings for the period July 1983 through December 1984. The study results indicate that Delta water supplies are generally of good quality with respect to pesticides and other agents that may affect human health.

Because of the continuing need to evaluate human health aspects of Delta water supplies, the program has been extended and expanded to include monitoring for selenium and also for specific pesticides used in watersheds tributary to the Delta. The next project report is scheduled for completion in October 1966.

James U. McDaniel
Chief, Central District

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ACKNOWLEDGMENTS

The authors of this report wish to thank the many persona who contributed information and ideas to this study. In particular, thanks are extended to the members of the Technical Advisory Committee of the Interagency Delta Health Aspects Monitoring Program. The committee, composed of representatives of participating agencies, helped the program become a reality and provided advice and support throughout its evolution. Also, appreciation is extended to Professor Perry McCarty, former chairman of the Scientific Panel Regarding Health Aspects of Delta Water Supplies, for his critical review of this document.

DELTA HEALTH ASPECTS MONITORING PROGRAM
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Over the 18 months of this study, water supplies taken from the Sacramento-San Joaquin Delta easily met primary drinking water criteria established to protect the health of consumera. Hydrologic conditions were abnormally wet during the study and, **therefore,** the data do not reflect average conditions. Under dry conditiona, concentrations of dissolved minerals in Delta **waters** would be higher than were observed in this atudy.

Levels of eodium found in Delta water **supplies** were well below levels recommended for protecting the health of individuals on moderately **restricted** eodium diets, but were above the recommended level for **persons** on severely restricted sodium diete. Sources of eodium to the Delta include natural leaching of minerals from soils, agricultural return draine, and the San Francisco Bay and Pacific Ocean.

Asbestos concentrations in Delta water supplies are highly variable. The **sources** of aebeetos in Delta watere are probably mostly of natural origin and would be difficult or impossible to control. The health **effects** of asbestos in drinking water are dieputed and, accordingly, no drinking water limits for asbestos have been established.

Trihalomethanes are potentially harmful organic chemicala that are formed in drinking water when chlorine used for dieinfection **comes** into contact with certain naturally occurring organic **substances** in the water. Delta water **supplies** have eubstantial potential for forming trihalomethanee in treated drinking water, **Waters** of the southern Delta are higher in **trihalomethane-**forming **compounds** than are waters of the streams tributary to the northern Delta.

Levels of organic pollutanta, including pesticides, were low during the **18-month** study. In all instancee, concentrations **were** far below drinking water maximum contaminant levels established by the U. S. Environmental Protection Agency and California Department of Health **Services.**

Effects of the San Joaquin River on State Water Project **supplies** have become eomewhat of an **issue,** but its effects are limited **because** of operational characteristics of the Project and Delta eystem. In any **case,** the San Joaquin River water was not found to contain significant level.3 of selenium or pesti**cides.** Sodium concentrations in the San Joaquin River were somewhat higher than other Delta tributaries, due **mostly** to agricultural drainage into the eystem.

Chapter 1. INTRODUCTION

In April 1982, the Department of Water Resources published the findings of its State Water Project Trihalomethane Study /1/. One of the findings was that water supplies exported from the southern Sacramento-San Joaquin Delta are higher in trihalomethane producing substances than are waters tributary to the northern Delta. This study led to increased awareness of human health factors related to Delta water supplies.

In August 1982, the Department of Water Resources appointed a scientific panel to assess the health aspects of Delta water used for domestic purposes. The panel was created because of concerns expressed by some agencies about the quality of the raw water supplies diverted from the Delta area for domestic use. The Department asked the panel to determine whether there were any health hazards that might result from use of surface water taken from the Sacramento River between Sacramento and the Delta or from the Delta itself, particularly at Clifton Court Forebay. Furthermore, the panel was asked about additional treatments other than standard procedures that might be used to reduce health hazards and the costs associated with them.

Findings of the panel were submitted to the Department on December 31, 1982, in "Public Health Aspects of Sacramento-San Joaquin Delta Water Supplies" /2/. Two major recommendations were:

1. Considerations of public health, as affected by the quality of drinking water, should be given a much higher priority in decisions about the Delta.

2. Data collection and analysis programs and other studies to resolve public health concerns should be actively pursued. A more comprehensive analytical framework (model) needs to be structured for analysis of the various alternatives that may be considered to meliorate future quality problems. Such a framework is also needed to help predict the effect of proposed system modifications on water quality at various intake locations. This framework should provide a quantitative understanding of the system response with appropriate adjustments for any area of uncertainty.

The panel concluded that drinking water supplies of Delta origin meet current drinking water standards, but observed that most of the then existing Delta water quality data had been collected to support environmental rather than human health objectives. The panel found uncertainties concerning some constituents in Delta water supplies and their sources. These included asbestos, sodium, and trihalomethane forming materials. In addition, the panel noted the absence of adequate data on concentrations of pesticides and other synthetic organic compounds in Delta water supplies.

To correct the deficiencies in data, the panel recowended that the Department establish a monitoring program specific to addressing the present and projected suitability of Delta waters as a drinking water supply. The program should identify the sources of contaminants to the Delta and how the contaminants from each source are transported through the system and affect the concentration at points of withdrawal. Information on factors affecting the movement and fate of the contaminants in the Delta is also needed to quantify water quality impacts at possible points of withdrawal. The monitoring program should be designed to

provide data that is appropriate for the model, which should be structured to examine the following :

- The location and magnitude of sources of sodium, asbestos, and organic material, including inflows to the Delta, current and proposed agricultural drainage discharges, waste water discharges, and seawater intrusion through the bay.
- Factors affecting the contribution8 from each important source, including streamflow rates, time of year, level8 of waste water treatment, and reservoir release patterns.
- The variability of constituent concentrations at critical Delta points as affected by their sources and Delta flow pat terns.
- The effects of Delta water quality, storage, transport, blending with other waters, and treatment on the quality of treated drinking water.

The panel recommendation was implemented in July 1983 with commencement of the Interagency Delta Health Aspects Monitoring Program. The program, initially established as an l&month effort, was a cooperative study among agencies having concerns about Delta water supplies. Participating agencies have included the U. S. Bureau of Reclamation, the City of Stockton, East Bay Municipal Utility District, and the water contractors of the State Water Project.

The overall strategy of the program is to address the panel's recommendations in several steps because of the limited understanding of the complex hydrodynamics of the Delta and because of limited funds.

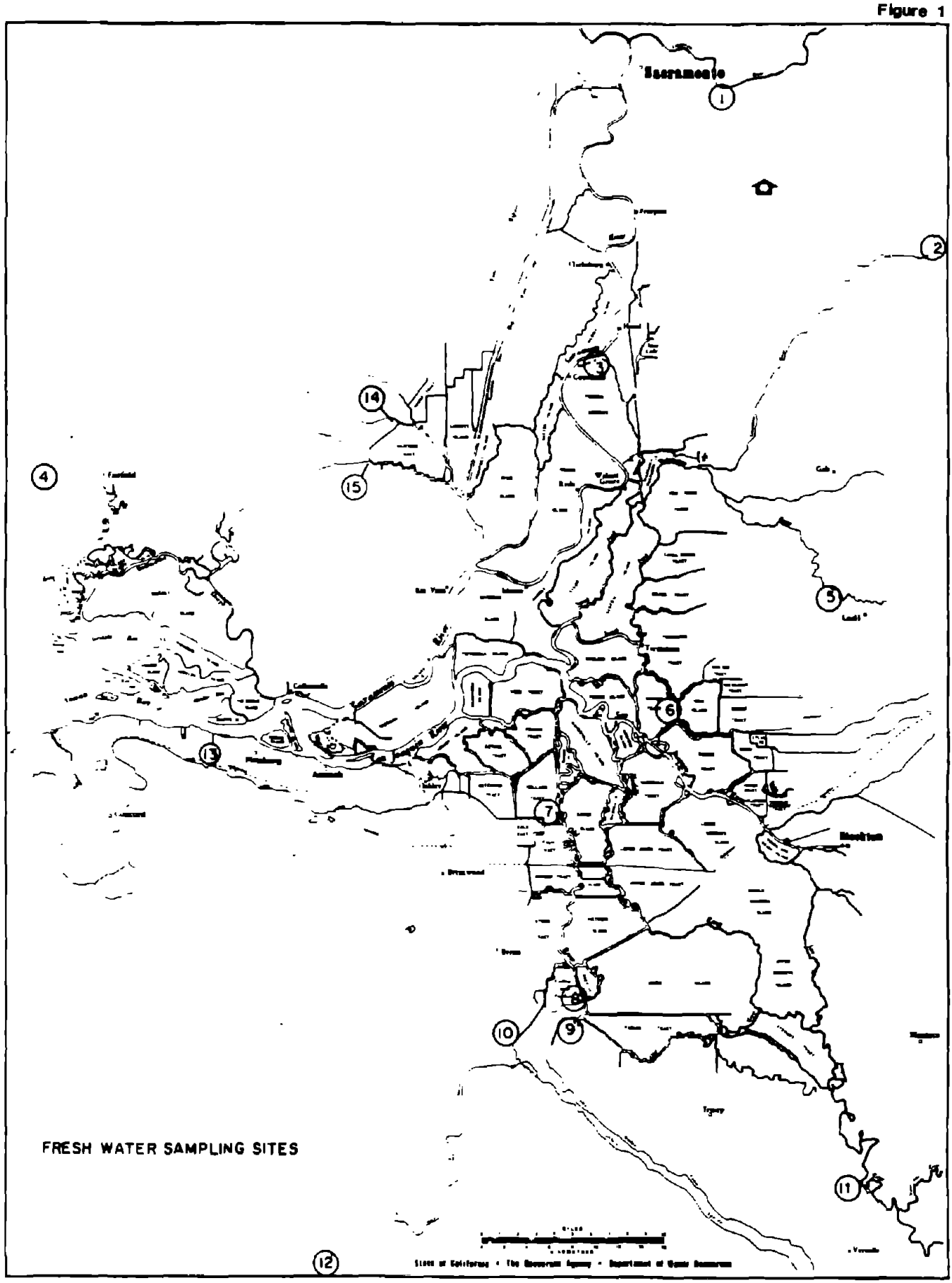
Initial monitoring efforts were directed at obtaining water quality data on sodium, asbestos, and organic chemicals that could affect drinking water quality. A Technical Advisory Group represented by the sponsoring agencies has placed priority on obtaining such data to assess current water quality conditions. Results of this preliminary work will assist in outlining relationships for the development of an overall comprehensive analytical framework.

As vork progresses and key relationships are identified and proposed for testing, monitoring efforts will intensify to refine the comprehensive analytical framework for integration into a mathematical model that could be used to predict water quality changes as affected by different future conditions. The Department and other agencies are already actively conducting studies on Delta hydrodynamics. Efforts beyond the preliminary phase of the recommended monitoring plan will be subject to future funding levels. A study plan to complete development of the panel's recommended comprehensive analytical framework is under development.

Listed below and number keyed to Figure 1 are the fresh water sampling stations monitored under the current program.

No.	Station
1	American River at Water Treatment Plant
2	Consumnes River at Dillard Road
3	Sacramento River at Greene's Landing
4	North Bay Interim Pumping Plant Intake
5	Mokelumne River at Lower Sacramento Road
6	Honker Cut at Eight-Mile Road
7	Rock Slough at Old River
8	Clifton Court at Intake
9	Delta-Mendota Intake Channel at Lindeman Road
10	Harvey 0. Banks Delta Pumping Plant Headworks
11	San Joaquin River near Vernalis
12	Lake Del Valle Stream Release
13	Mallard Slough at Pumping Plant
14	Cache Slough at Vallejo Pumping Plant
15	Lindsey Slough at Hastings Cut

Figure 1


Sacramento
1
2
3
4
5
6
7
8
9
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11
12
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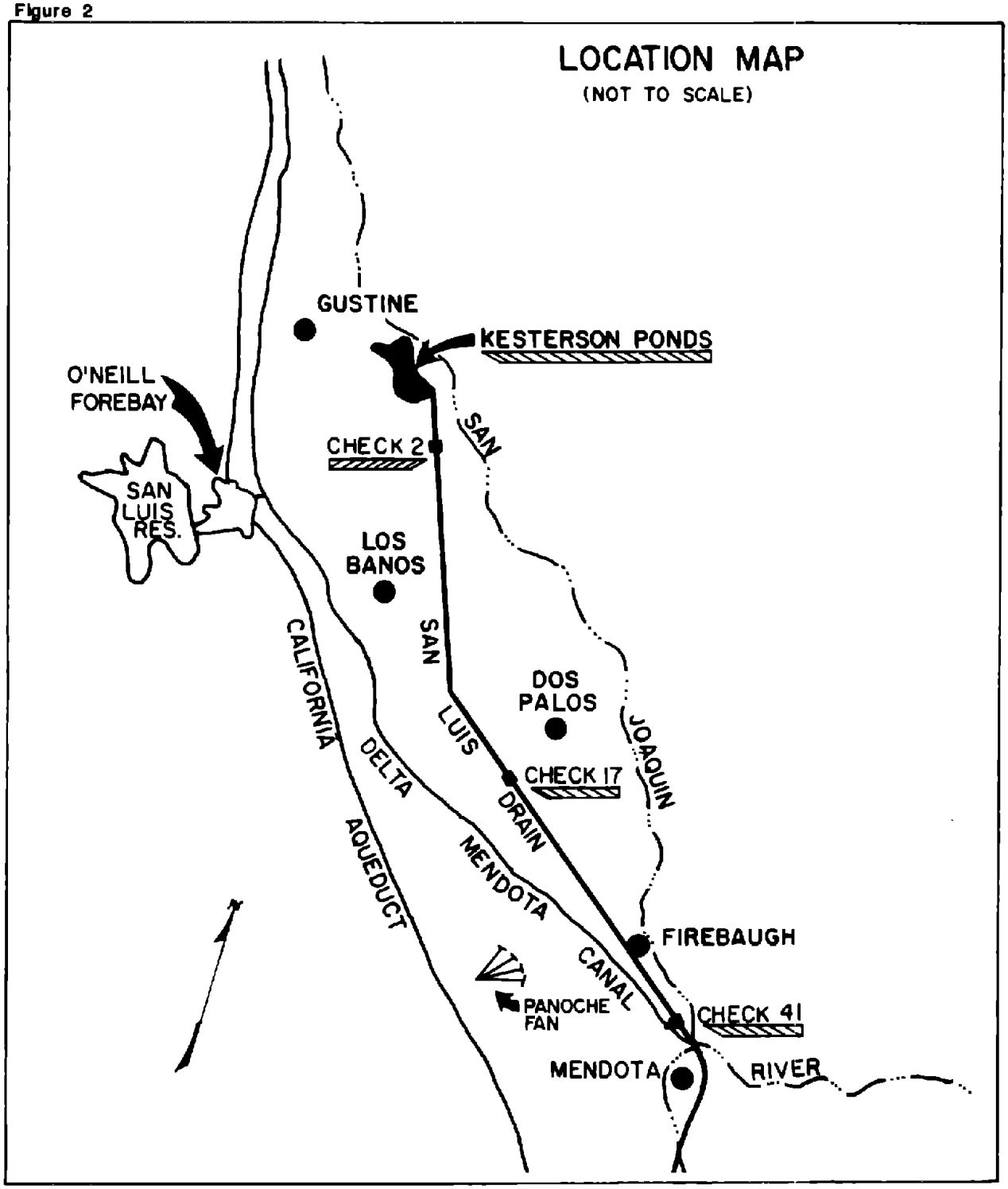
14
15
FRESH WATER SAMPLING SITES

At the request of the U. S. Bureau of Reclamation, the San Luis Drain system was included in the monitoring program. The purpose of its inclusion was primarily to determine whether trihalomethane formation potential has constituted a water quality problem in water from the drain. Figure 2 depicts the monitoring locations in the San Luis Drain system that were monitored from July through December 1983. They were:

Kesterson Pond No. 5
Check 2, San Luis Drain
Check 17, San Luis Drain
Check 41, San Luis Drain

Figure 2



Chapter 2. FINDINGS AND CONCLUSIONS

The following are the findings and conclueione of the Interagency Delta Health Aspects Monitoring Program for the period July 1983 through December 1984.

Findings

1. Sodium levels at locations monitored in this program have been below established drinking water criteria for people on moderately restricted sodium diets. Recommended levels for protection of persona on severely restricted sodium diets were, however, exceeded.

2. Asbestos concentrations in waters of the Delta and its tributary streams are highly variable. There is no drinking water standard for asbeetoe. Because of unresolved questions as to the health effects of ingested asbestos. health officials recommend water be treated to remove as much aabestos as possible with standard processes.

3. Selenium in Delta water supplies waa found only at barely detectable levels , no more than one-tenth the established drinking water Maximum Contaminant Levels.

4. Trihalomethane formation potentials of southern Delta water suppliee are higher than in waters tributary to the northern Delta. The increased formation poteatiale are attributable to increased organic trihalomethane precursors and also to presence in the water of the mineral bromide.

5. Only a few of the 129 priority pollutants were detected in project samples. Concentrations of compounds observed were below levels expected to pose significant risk to consumers.

6. Concentrations of pesticides were far below established drinking water limit6 in all project samples.

7. Levels of selenium and pesticides found in the San Joaquin River were very low.

Conclusions

1. Sodium concentrations were generally below levels expected to cause health problems for anyone except people on severely restricted eodium diets. For thoee people, the levels may be high, but they normally would use bottled water.

2. Although the number of selenium samples taken wae limited, no data were developed to suggest that selenium constitutes a health threat for consumers of Delta water supplies .

3. From the standpoint of synthetic organic pollutants, data collected in this program indicate Delta water supplies are of good quality. Further monitoring is necessary to strengthen this conclusion.

4. Because moat of the State's agricultural lands are in waterahede tributary to the Delta, water eupplies taken from the Delta are particularly vulnerable to pesticide contamination. Sampling during fall 1984 for specific pesticides wst used in Delta watersheds indicates that these agents are not entering Delta waterways in signif icant quantities . Although further monitoring would be required to verify this finding,

preliminary indications are that Delta water supplies are not significantly polluted by pesticides, at least during the fall.

5. Although little San Joaquin water is taken into the State Water Project because of the manner in which the project is operated, the San Joaquin River has been the subject of great concern recently with regard to its effect on Delta water supplies. Data collected under this program and from other sources indicate that San Joaquin River water is not higher in pesticide concentrations than that of other streams tributary to the Delta, such as the Sacramento River. Pesticide levels in water samples from all streams measured were far below established drinking water limits. Selenium data collected by this Department and reinforced by data collected by the U. S. Geological Survey strongly demonstrate that the San Joaquin River is not currently a significant source of selenium to Delta water supplies, although the possibility of future impacts cannot be dismissed.

Chapter 3. RECOMMENDATIONS

1. The data collected under the Interagency Delta Health Aspects Monitoring Program should be used to develop a comprehensive analytical framework for evaluating human health aspects of Delta water supplies. The program should be extended an additional 18 months to collect data needed to satisfy the anaytical framework.

2. because asbestos concentrations are highly variable, a very large number of samples would have to be collected and analyzed to determine asbestos levels in the Delta and its tributaries with confidence. Also, recent investigations have failed to indicate that waterborne asbestos causes cancer. Due to these considerations and to the cost of the sample analyses, reduction in frequency of asbestos monitoring to once each six months at the regular sampling stations in the program is recommended.

3. Because of the continued concern regarding selenium in Delta water supplies, monthly monitoring for this constituent should continue at the San Joaquin River, Banks Pumping Plant, Delta-Mendota Canal, Sacramento River, and Lindsey Slough monitoring sites.

4. Sampling for trihalomethane potential should be reduced from once per month to once every other month at each of the regular monitoring locations during the summer and winter months. Monthly monitoring should be continued during spring and fall months when hydrologic instability occurs, Because sample filtration ordinarily has no significant effect on trihalomethane potent ial, filtration should be discontinued.

5. Monitoring for bromide3 should be performed to evaluate the effects of these salts on trihalomethane formation potential of Delta water sources. Analysis of the samples should be sufficiently sensitive to detect bromide levels that are significant in trihalomethane formation.

6. Monitoring for organic priority pollutants should continue once each six months at the regular sampling locations in the program. Although previous monitoring has shown very low levels of these pollutants, continued surveillance-level monitoring will provide assurance that the levels remain low. Further effort should be devoted to developing field techniques for integrating and concentrating samples for organic pollutant analyses; such techniques are needed to increase the degree of confidence in detecting compounds present in monitored streams.

7. Monitoring for specific pesticides should continue quarterly at each of the regular sampling stations, and typical agricultural drainages into the Delta and its tributaries should be included. To accomplish this monitoring, the moat recent available pesticide use data should be analyzed to identify the most used pesticides. The environmental behavior of these agents should be evaluated to determine which of them should receive monitoring priority. Then, sampling should be conducted for the highest priority pesticides, at times and in places with the greatest likelihood of finding them in the water.

8. Previous monitoring has demonstrated that health aspects of the water

quality of the Mokelumne and Cosumnes rivers is excellent. For the sake of program economy, these stations should be eliminated from the list of regular sampling locations. Because development is proceeding in these watersheds, future negative impacts on stream water quality are possible. Accordingly, the two locations should be resampled in 3 to 5 years to determine whether or not these streams continue to have excellent water quality.

9. To the extent program funding permits, more intensive monitoring of the San Joaquin River watershed should be undertaken to determine whether there is significant potential of pollution of Delta water supplies with pesticides and selenium from this source.

Chapter 4. METHODS

The following sections describe sampling apparatus, sampling methods, and analytical methods employed in the Interagency Delta Health Aspects Monitoring Program.

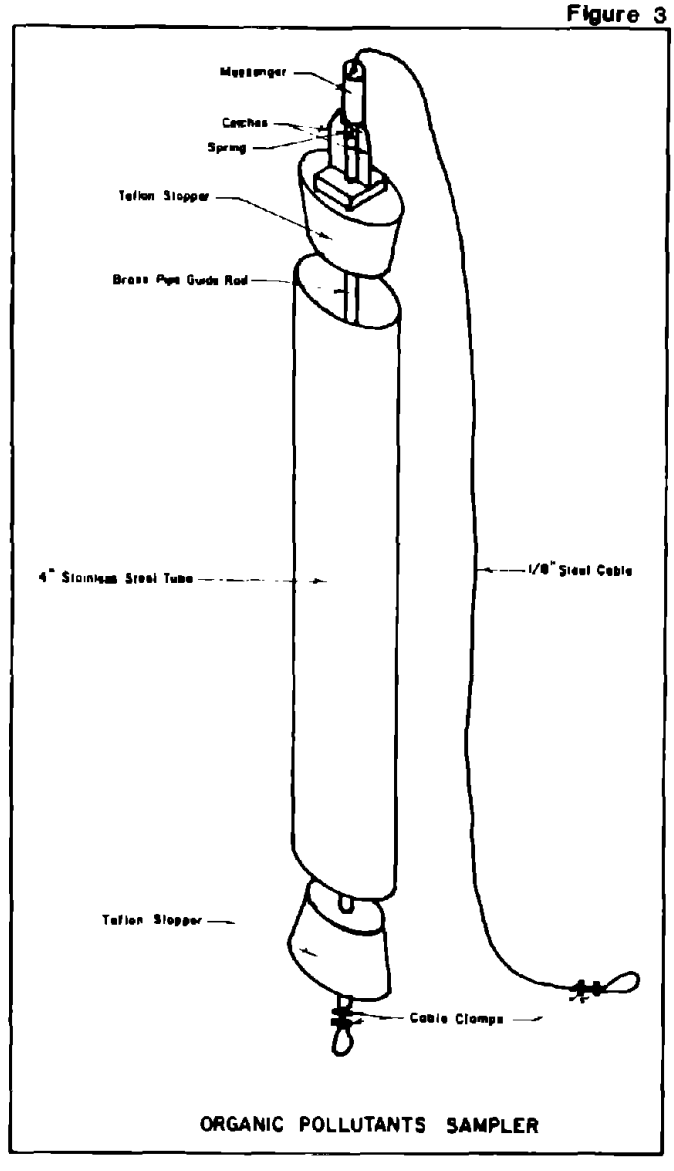
Sampling Apparatus

Prior to January 1984, samples were collected in a 1.5-liter steel bucket with a one-meter chain attached; the bucket and chain were prepared for sampling by detergent washing and drying. The equipment was transported in detergent-washed aluminum foil. Sampling involved attaching a small diameter nylon rope to the end of the chain and dipping the bucket into the water to collect the sample. To avoid contamination, the rope was not allowed to enter the water.

Beginning in January 1984, and continuing since then, samples have been collected using a specially constructed device developed by the Department of Water Resources (see Figure 3). A stainless steel tube with Teflon® closures and a triggering mechanism are the main components of the device, which was produced using parts from old Kemmerer® samplers. The important features of the device are: (1) it enables subsurface sampling, and (2) the water being sampled is not in contact with potentially contaminating materials.

Before being used for the first time, the device was soaked for about a week in water containing detergent. This procedure was intended to cleanse the equipment of any surface contaminants that may have been present.

Figure 3



ORGANIC POLLUTANTS SAMPLER

Prior to sampling, the device was washed in detergent, rinsed, dried, and wrapped in detergent-washed foil. A nylon rope attached to a short length of steel cable was used to suspend and operate the sampler. As was the case with the sampling bucket, the rope was not allowed to contact the water.

Sampling Methods

Samples for Total Trihalomrthane Formation Potential analyses were filtered through 0.45uM Type HA Millipore® membranes, using a stainless steel filtration apparatus that was waahed in detergent, rinsed, dried, and wrapped in detergent-washed foil prior to sampling. The purpose of the filtration was to simulate the clarification and filtration processes employed in water treatment.

Filtration apparently has on.y a minor effect on trihalomethane formation potential of most fresh water samples. Twenty-five fresh water samples were analyzed in duplicate, on2 sample being filtered and the other unfiltered. The average difference between the filtered and unfiltered samples was 14 percent; this difference is in the order of magnitude of the analytical variation of the test method. Filtered water was poured into 40 mL screw-top vials with Tef lon® septa, leaving no airspace, as specified by the U. S. Environmnental Protection Agency /3/.

Water samples for total organic carbon analyses were Poured into acid-fixed 30 mL glass bottles with tapered glass stoppers, then sealed with washed foil.

Samples for the above analyses were transported iced to the DWR Bryte Laboratory within 24 hours of sampling.

Field analyses were performed at the time of sampling. Temperatures were taken by means of a radial thermometer graduated in intervals of 0.5 degrees Celsius. Measurements of pH were performed by use of a Hellige colorimetric pH comparator. Dissolved oxygen concentrations were determined in the field by the modified Winkler titration method, and electrical conductivity was determined by use of a Beckman SoluBridge® for conductivities less than 8,000 umhos/cm and a Beckman Model RC-19® electrical conductivity bridge for higher conductivit ies .

Asbestos samples were collected in pint-sized polyethylene bottles and shipped on the day of collection via express mail to the EMS Laboratory in Hawthorne, California. Priority pollutant samples were collected in gallon containers, three per sample (for extractables). Also, 40 mL samples were collected in glass containers (five per sample) for volatile organic analyses. The sample containers were completely filled, eliminating headspace. Volatilization losses during filling were minimized by tilting sample vials and allowing the sample to run down the inside of the vial without causing turbulence. The caps of the sample containers were Teflon@-lined. These samples were delivered to McKesson Environmental Services laboratory in Dublin, California, within 24 hours of collection.

Analytical Methods

Upon delivery to the DWR Bryte Laboratory, raw water samples for trihalomethane formation potential analyses were chlorinated at about 50 milligrams per liter (mg/L) chlorine dosage. This high dosage was used to assure a chlorine residual after the 7-day incubation period at 25 degrees Celsius. This procedure should be acceptable, as studies have determined that ultimate trihalomethane formation is independent of dosage, where the dosage exceeds the chlorine demand of the sample /4/. At the end of seven days, samples were dechlorinated using sodium thiosulfate and analyzed by the purge and trap method of gas chromatographic analysis established by EPA /3,5/. Asbestos samples and priority pollutant samples were likewise analyzed by methodology established by EPA /6,7/. Selenium was analyzed by a method developed by the U. S. Geological Survey for its low detection Level work /8/. All other analyses were performed according to Standard Methods /9/.

Quality Control

The laborator iee performing analyses for the Interagency Delta Health Aspects Monitoring Program employ rigorous quality control procedures to assure validity of reported results. Sample handling and storage are carefully controlled to reduce the likelihood of errors in sample identification and integrity. Also, analytical quality control procedures, involving sample spikes and duplicates, are undertaken to assure accurate results. Details of detection limits and other quality control matters are found in Appendix B.

Chapter 5. DISCUSSION OF RESULTS

The following is a discussion of the results of sampling conducted under the Interagency Delta Health Aspects Monitoring Program during the period July 1983 through December 1984.

Drinking Water Quality

Water supplies taken into the State Water Project from the Sacramento-San Joaquin Delta have consistently met primary drinking water quality criteria established to protect the health of consumers /9a/. As an example, Table 1 compares estabiiehed drinking water Maximum Contaminant Levels to measured quality of water taken from the State Water Project near the terminals of the California Aqueduct and South Bay Aqueduct . Depicted are data on inorganic, organic, and radiologic constituents demonstrating compliance with State drinking water standards in 1984. The data are from The Metropolitan Water District of Southern California and the Santa Clara Valley Water District, both of which are contractors of the State Water Project. The water supply of the State Water Project is taken from Old River in the southern Delta (refer to Figure 1).

Sodium

The National Academy of Sciences (NAS) has recommended drinking water sodium limits for people on restricted sodium diets /10/. The NAS recommended limit for people on a severely restricted sodium diet is 20 mg/L (milligrams per liter, or part9 per million parts water). The recommended limit for people on moderately restricted eodium diets is 270 mg/L. The 20 mg/L limit is of questionable use for evaluating raw water supplies, because people on severely restricted sodium diets would ordinarily consume bottled water containing no sodium.

Sodium data collected from fresh water sampling locations are listed in Appendix A and summarized in Figure 4; the figure depicts the minimum, median, and maximum sodium concentrations measured. Because there are insufficient data to determine whether the data are normally distributed, the median is a better estimate of central tendency than is mean. The maximum sodium level recorded was 87 mg/L, well below the 270 mg/L limit recommended for people on a moderately restricted sodium diet.

The Mokelumne, American, Cosumnes, and Sacramento rivers had very low sodium levels, as did water at the Interim North Bay Pumping Plant Intake, which is supplied from Lake Berryessa. Waters of the southern Delta, including the Rock Slough, Clifton Court, Banks Pumping Plant, and San Joaquin River stations, had higher levels. Also higher in sodium levels were the waters of Cache Slough and Lindsey Slough, which are in the northern Delta area.

Sodium levels in southern Delta waters are higher because these waters receive agricultural drainage from within the Delta and its tributary streams; also, because Delta water supplies are hydraulically connected to San Francisco Bay and the Pacific Ocean, salt from this source can mix with fresh Delta water. Agricultural drainage and presence of treated waate water can also explain the increased sodium levels appearing in Cache and Lindsey sloughs. (Treated waste water is discharged indirectly into Cache Slough from the Easterly waste treatment facility of the city of Vacaville.)

Table 1

COMPARISON OF CALIFORNIA PRIMARY DRINKING WATER STANDARDS
WITH DRINKING WATER OF STATE WATER PROJECT ORIGIN

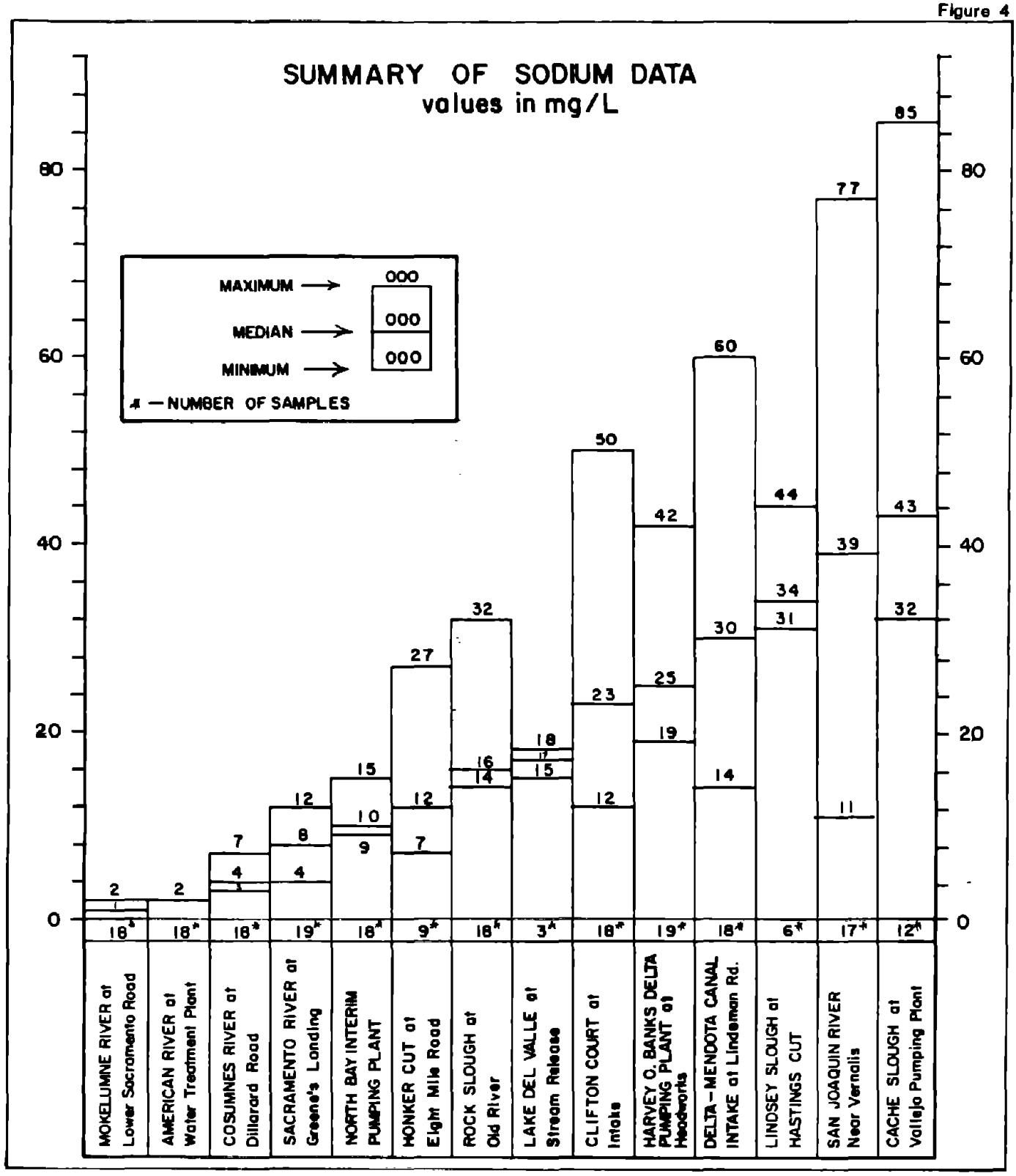
Constituent	Maximum Contaminant Level	Concentration in Drinking Water of State Water Project Origin 1/	
		Santa Clara Valley 2/	Southern California 3/
Inorganic Chemicals (Values in milligrams per liter, or parts per million)			
Arsenic	0.05	<0.01	0.003
Barium	1	0.08	0.017
Cadmium	0.010	<0.001	<0.001
Chromium	0.05	<0.004	<0.006
Lead	0.03	<0.01	<0.003
Mercury	0.002	<0.001	<0.0006
Nitrate (as NO3)	45	1.2	0.85
Selenium	0.01	<0.010	<0.002
Silver	0.05	<0.01	<0.005
Fluoride	1.4 to 2.4 (Depends on Temperature)	<0.2	0.37
Organic Chemicals (Values in milligrams per liter, or parts per million)			
Trihalomethanes	100	60	58
Endrin	0.002	<0.0001	<0.0001
Lindane	0.004	<0.00005	<0.0001
Methoxychlor	0.1	<0.0002	<0.0002
Toxaphene	0.005	<0.001	<0.0002
2,4-D	0.1	<0.0001	<0.001
2,4,5-TP Silvex	0.01	<0.0001	<0.001
Radioactivity (Values in picocuries per liter)			
Combined Radium-226 and Radium-228	5	<0.1	<0.1
Gross Alpha	15	<0.5	0.9
Tritium	20,000	<1000	140
Strontium-90	8	<3	0.5
Gross Beta	50	2	2.7

1/ Title 22 of the California Administrative Code requires sampling for inorganic chemicals on an annual basis, organic chemicals each three years, and radiologic contaminants for consecutive quarters each four years to demonstrate compliance with drinking water standards. < = Concentration below stated value.

2/ Data from Santa Clara Valley Water District, 1984.

3/ Data from The Metropolitan Water District of Southern California, 1984.

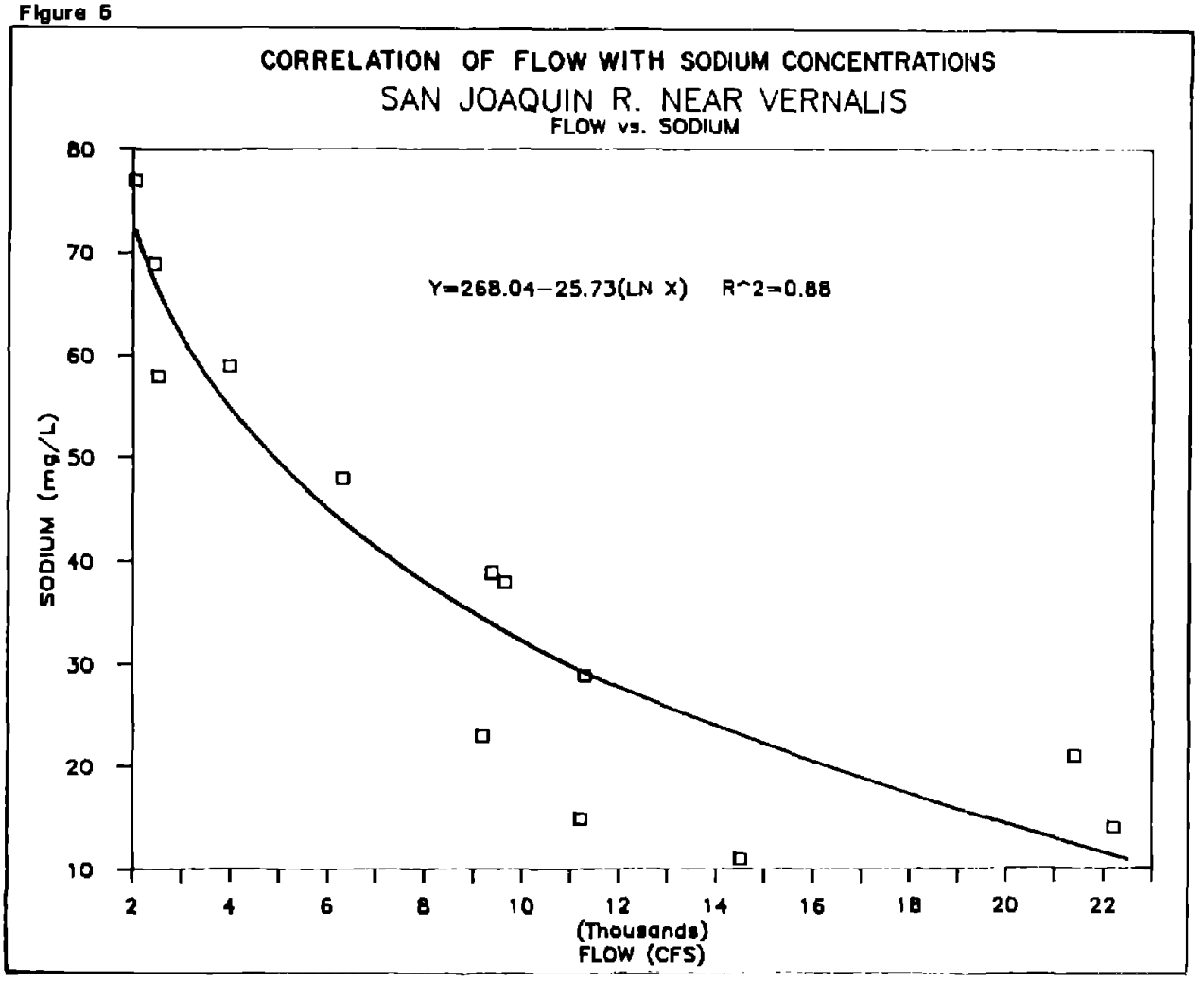
Figure 4


SUMMARY OF SODIUM DATA
values in mg/L
MAXIMUM
MEDIAN
MINIMUM
— NUMBER OF SAMPLES
000
000
000
0
20
40
60
80
MOKELUMNE RIVER at Lower Sacramento Road
AMERICAN RIVER at Water Treatment Plant
COSUMNES RIVER at Dillarard Road
SACRAMENTO RIVER at Greene's Landing
NORTH BAY INTERIM PUMPING PLANT
HONKER CUT at Eight Mile Road
ROCK SLOUGH at Old River
LAKE DEL VALLE at Stream Release
CLIFTON COURT at Intake
HARVEY O. BANKS DELTA PUMPING PLANT at Headworks
DELTA-MENDOTA CANAL INTAKE at Lindeman Rd.
LINDSEY SLOUGH at HASTINGS CUT
SAN JOAQUIN RIVER Near Vernalis
CACHE SLOUGH at Vallejo Pumping Plant
18* 18* 18* 19* 18* 9* 18* 3* 18* 19* 18* 6* 17* 12*
2 2 7 12 15 27 32 18 50 42 60 44 77 85
1 4 8 10 9 12 7 16 14 17 15 23 12 25 19 30 14 34 31 39 11 43 32

Regression analyses were performed to determine the correlation of sodium concentrations to other measured parameters. A positive correlation between flow and sodium was observed for the San Joaquin River. Of the four equation forms tested, the best fit was of the form y=a+b ln(x). The coefficient of determination (r-squared) was 0.88. Figure 5 is a plot of the regression curve obtained for the San Joaquin River. (An r-squared of 1.0 denotes a perfect positive correlation, while an r-squared of 0 indicates no correlation.) None of the other correlations was satisfactory. The relationship of sodium to flow in the San Joaquin River probably reflects effects of agricultural drainage, which becomes diluted with increasing river flow.

During the course of this program, the decision was made to locate the intake of the proposed North Bay Aqueduct in Barker Slough, a tributary to Lindsey Slough. One reason for this choice was to achieve the highest possible mineral quality in the export water. The data collected thus far do not show that sodium levels in Lindsey Slough would be markedly better than in neighboring Cache Slough. However, because fewer samples have been taken of Lindsey Slough than of Cache Slough water (6 versus 12), the data from the two stations may not be entirely comparable. Another consideration in evaluating the quality of Lindsey Slough water is that considerable improvement is expected once the North Bay Aqueduct is operational. Water quality routing

Figure 5



work by the Department of Water Resources has demonstrated that when the North Bay Aqueduct is fully operational, the primary source of export water will be the Sacramento River through Miner and Steamboat sloughs /10a/. Therefore, the mineral quality of North Bay Aqueduct water should be strongly influenced by that found at Greene's Landing on the Sacramento River.

Sodium levels in the San Luis Drain ranged from 1,760 to 2,980 mg/L (refer to Appendix A). These elevated sodium levels should have no relationship to human health aspects of Delta water supplies, however, because the San Luis Drain system is not tributary to the San Joaquin River or the Delta.

Asbes toe

Asbeatos is a naturally occurring mineral composed primarily of magnesium silicate. It is of health concern because studies have demonstrated that it is capable of causing lung cancer in humans when inhaled. Fibers more than 8 micrometers (uM) long and less than 0.25 uM in diameter are thought to be the most carcinogenic /11/. Besides the lungs, people exposed to airborne asbestos have also developed cancer of the abdominal lining /12/. One hypotheeis for abdominal cancer formation is that asbestos particles may be ingested as well as inhaled and, once in the digestive tract, the particles may be able to penetrate to the digestive tract lining to cause cancer there /13/. This hypothesis led to concern that waterborne asbeatos fibers may cause abdominal cancer.

Asbeetos has been demonstrated to be widespread in the environment. A survey of the drinking water of 426 cities in the United Statee showed asbestos concentrations exceeding 1 million fibers per liter (MF/L) in SO of the water supplies sampled /14/. For a time, researchers and health officials were quite concerned about asbestos in drinking water. However, recent studies failed to demonstrate that waterborne asbestos is a health hazard /15,16/. For this reason, the U. S. Environmental Protection Agency no longer identifies the asbestos issue as being of highest priority and has not established a Maximum Contaminant Level for asbestos.

Appendix A presents the asbestos data collected in the program, and the data are summarized in Figure 6.. The recorded asbestos values were highly variable, The American River samples, as an example, had generally lower asbestos levels than other etations sampled (median 150 MF/L) but had one value of 2,200 MF/L. Actual asbestos concentrations in the water are probably quite variable, but analytical variation is also important.

Aabestos analyeee are performed by means of an electron microscope, because ordinary light rnicroacopes are not capable of the magnifications necessary for the analyeis. Because of their small size, ident if icat ion and counting of asbestos fibers are difficult and subject to several types of errors. Therefore, asbestos analyses are inherently difficult, costly, and error prone.

In view of the small number of samples collected in this program and the high variability of the data, only general conclusions can be drawn. Apparently the Mokelumne, Cosumnes, and American rivere are low in asbestos concentrat ions, as is the water of Lake Del Valle. The low levels in the lake indicate asbestoe in the water might adsorb to particulate matter, then settle out of the water column. Work by the Metropolitan Water District of Southern California on reservoirs in the southern portion of the State Water Project tends to confirm this hypothesis /7/.

Of the stations sampled more than twice, the highest median and maximum asbestos levels were recorded at the Interim North Bay Pumping Plant Intake. This water comes from Lake Berryessa, whose watershed contains significant serpentine deposits, one of the asbestos-bearing mineral formations.

Figure 6

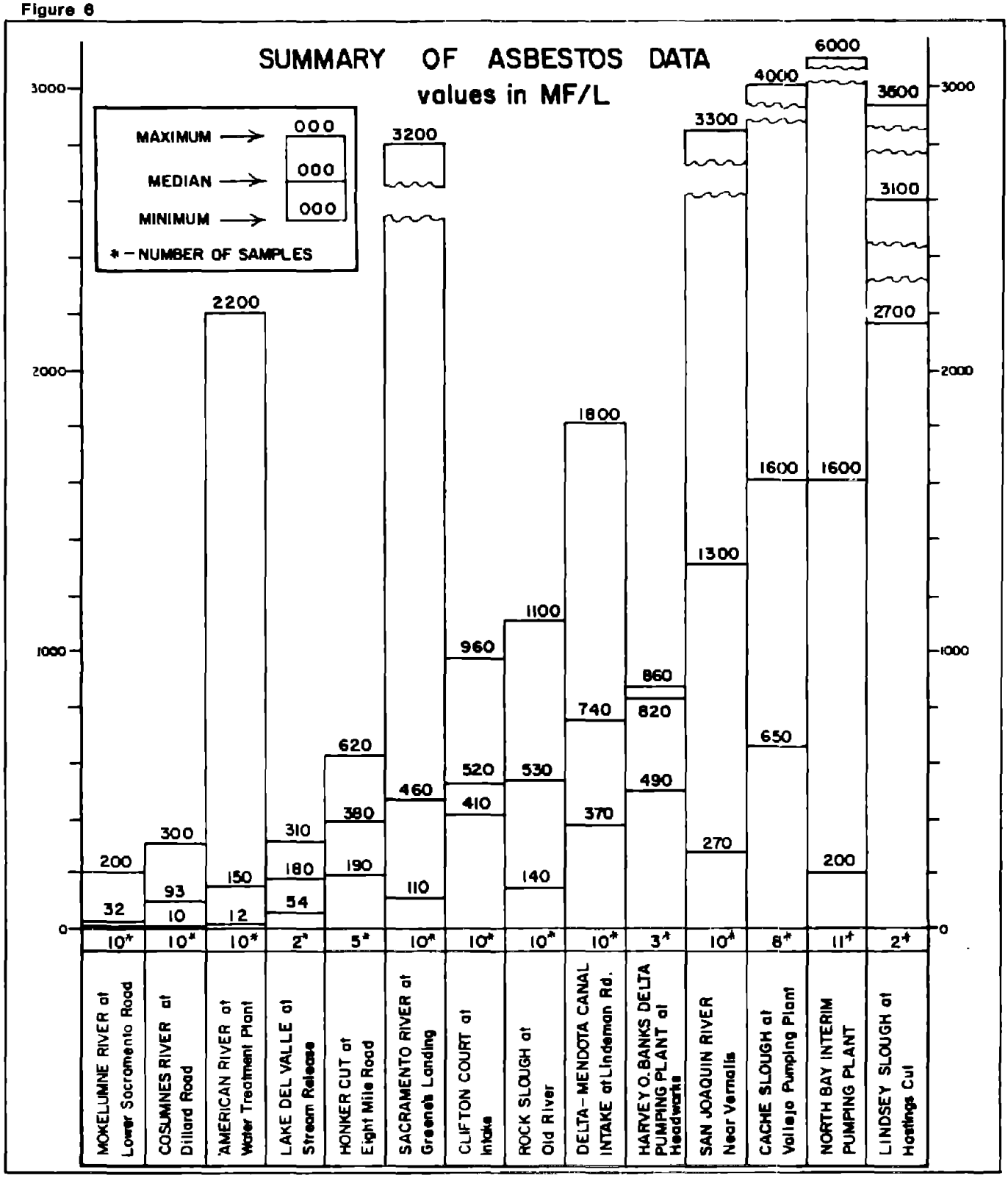
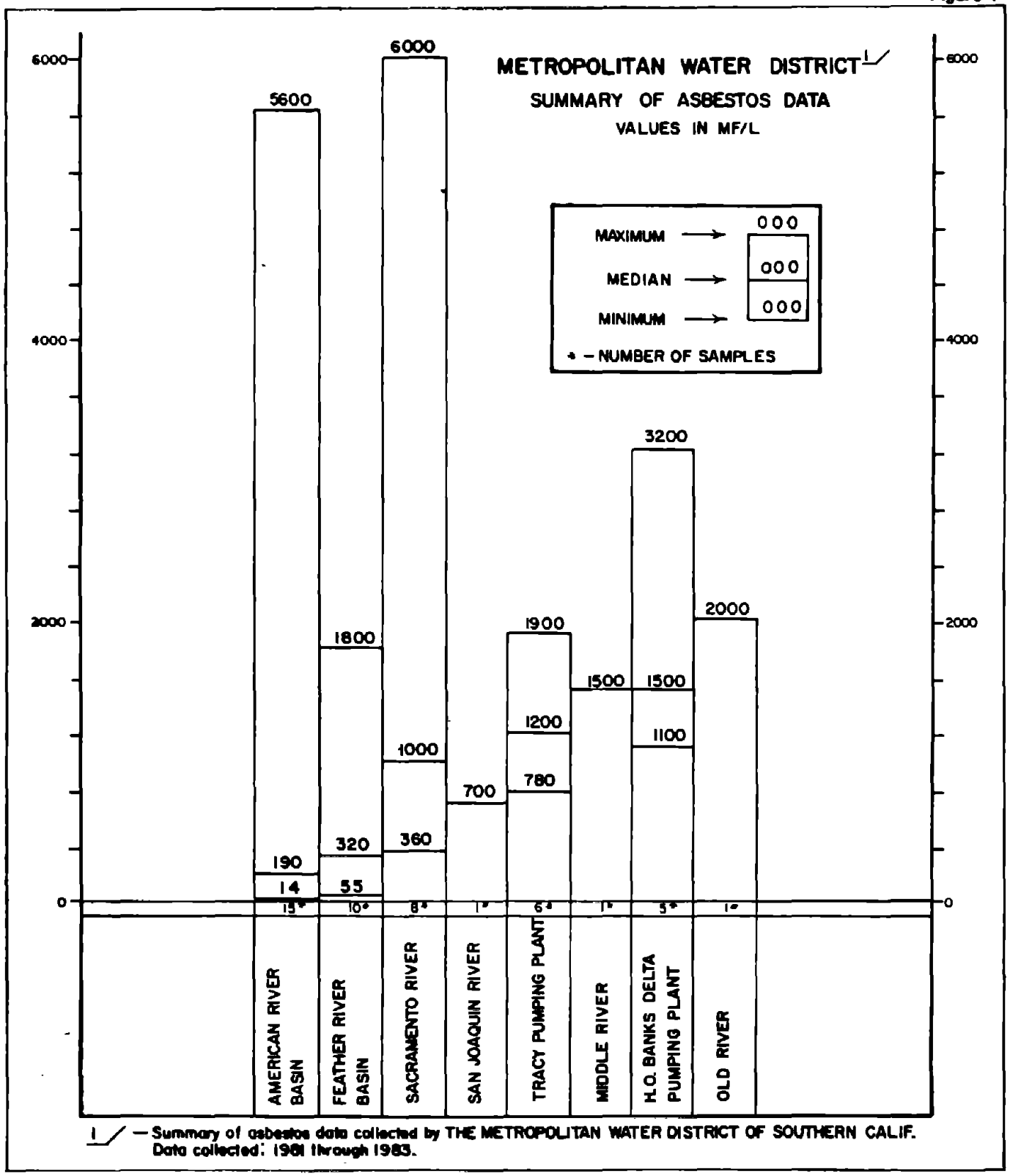


Figure 7 summarizes data reported by Hayward from locations similar to those monitored in this program. The observation was made that asbestos concentrations appeared to increase following storms /18/.

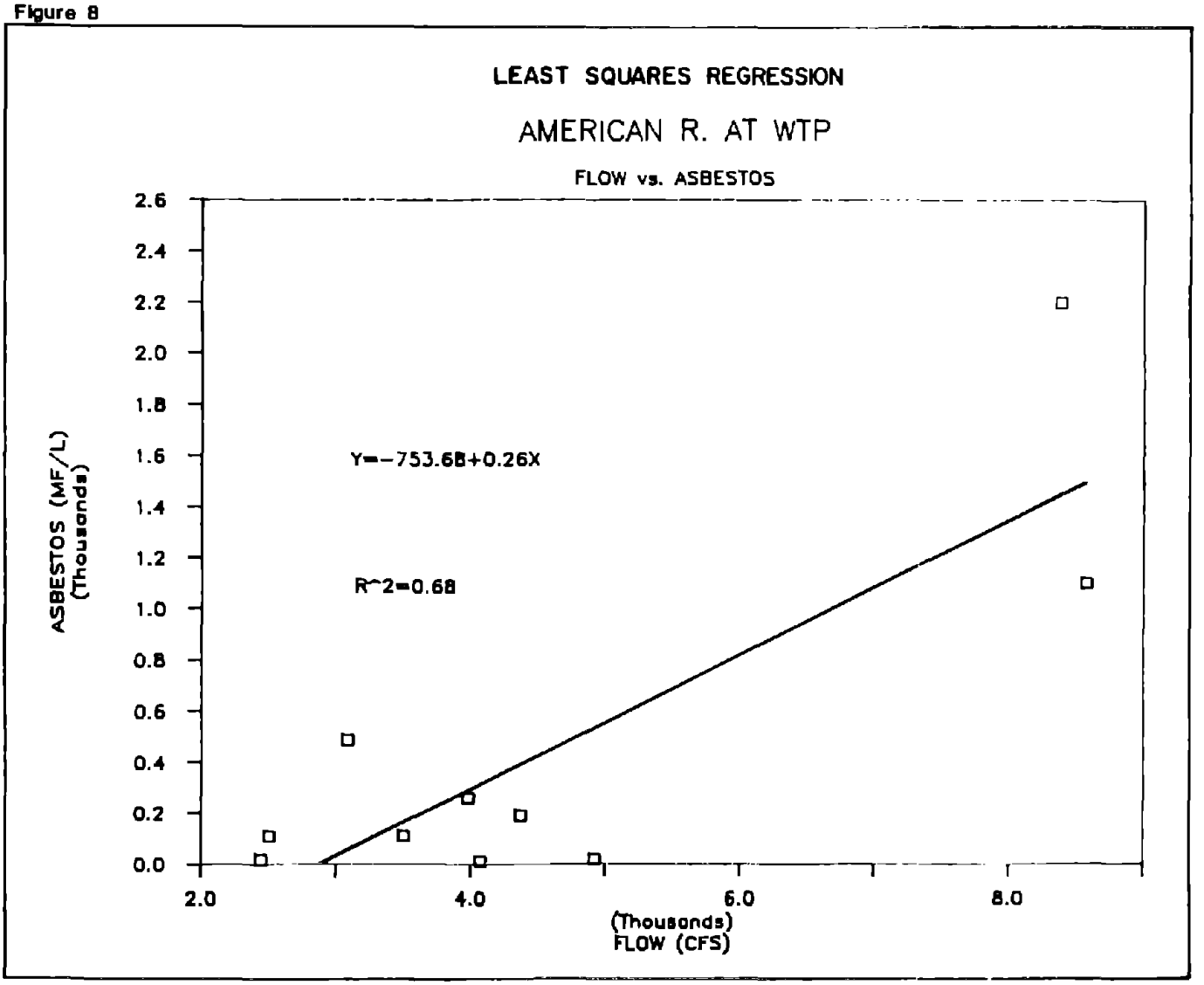
Figure 7



Regression analyses were done to determine whether observed asbestos concentrations were correlated with flow. Positive correlations were observed for the American, Mokelumne, and Sacramento river locations. The linear equation provided the best fit, with coefficients of correlation of 0.68, 0.77, and 0.93, respectively. Figures 8, 9, and 10 are plots of the regressions.

Asbestos is efficiently removed by water treatment plants. Table 2 summarizes data taken from two plants. The Penitencia Water Treatment Plant, a facility of the Santa Clara Valley Water District, receives its water through the South Bay Aqueduct of the State Water Project. The American River Water Treatment Plant of the city of Sacramento takes water from the American River. Hourly samples were collected over a 24-hour period; both the influent and finished drinking water were sampled. The hourly samples were composited, and the composites analyzed for asbestos. Although the Penitencia plant had higher measured asbestos concentrations in the influent water, its finished water was lower than was the water from the American River plant.

Figure 8

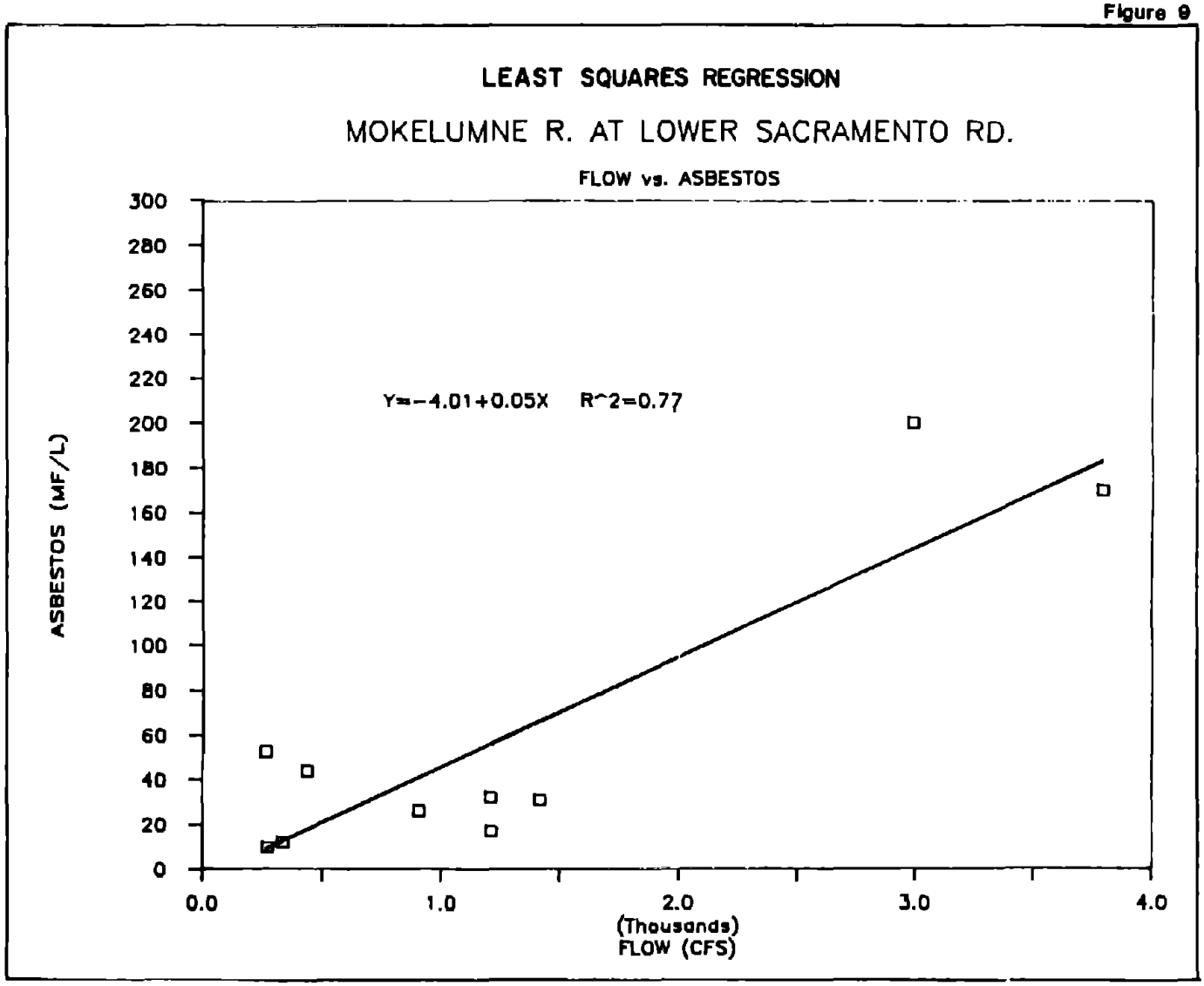


The asbestos removal efficiency of the Penitencia plant may be higher because the more turbid water of the South Bay Aqueduct enhances floc formation in water treatment, which would tend to maximize asbestos removal.

Although not directly connected to Delta water supplies, the State Water Project has had problems with asbestos in waters arriving from the Delta through the California Aqueduct. In the San Luis division of the California Aqueduct, upstream drainage enters the aqueduct at a number of locations. A major source of asbestos is Arroyo Pasajero Creek, and during times of high surface runoff, water enters the California Aqueduct from the creek. The watershed of the creek contains commercial asbestos deposits, and the creek carries high concentrations of asbestos fibers. The effect of the inflow has caused asbestos concentrations in the California Aqueduct downstream of Arroyo Pasajero to be as high as 15,000 MF/L, where only 100 to 1,200 MF/L concentrations appear upsteam.

The Metropolitan Water District of Southern California takes water from the southern portion of the State Water

Figure 9



Project. Over 14 months of monitoring, asbestos concentrations in the raw water supply in the East Branch of the State Water Project had asbestos concentrations ranging from 79 to 1,700 MF/L /17/. The samples were taken at Devil Canyon Afterbay, which is downstream of Lake Silverwood and upstream of Lake Perris, the terminal reservoir of the East Branch. The greatly reduced asbestos concentrations at this location (as compared to those at Arroyo Pasajero) partially reflect the effects of asbestos settling out in Lake Silverwood.

Alternative plans to eliminate inflow of Arroyo Pasajero water to the California Aqueduct are being considered. This could markedly reduce asbestos concentrations in the State Water Project south of Arroyo Pasajero. Meanwhile, Metropolitan Water District has done considerable work in its water treatment plant processes for asbestos removal. The effort has resulted in considerable reductions of finished water asbestos concentrations. Under optimized treatment conditions, removal rates are generally greater than 90 percent /20/.

Figure 10

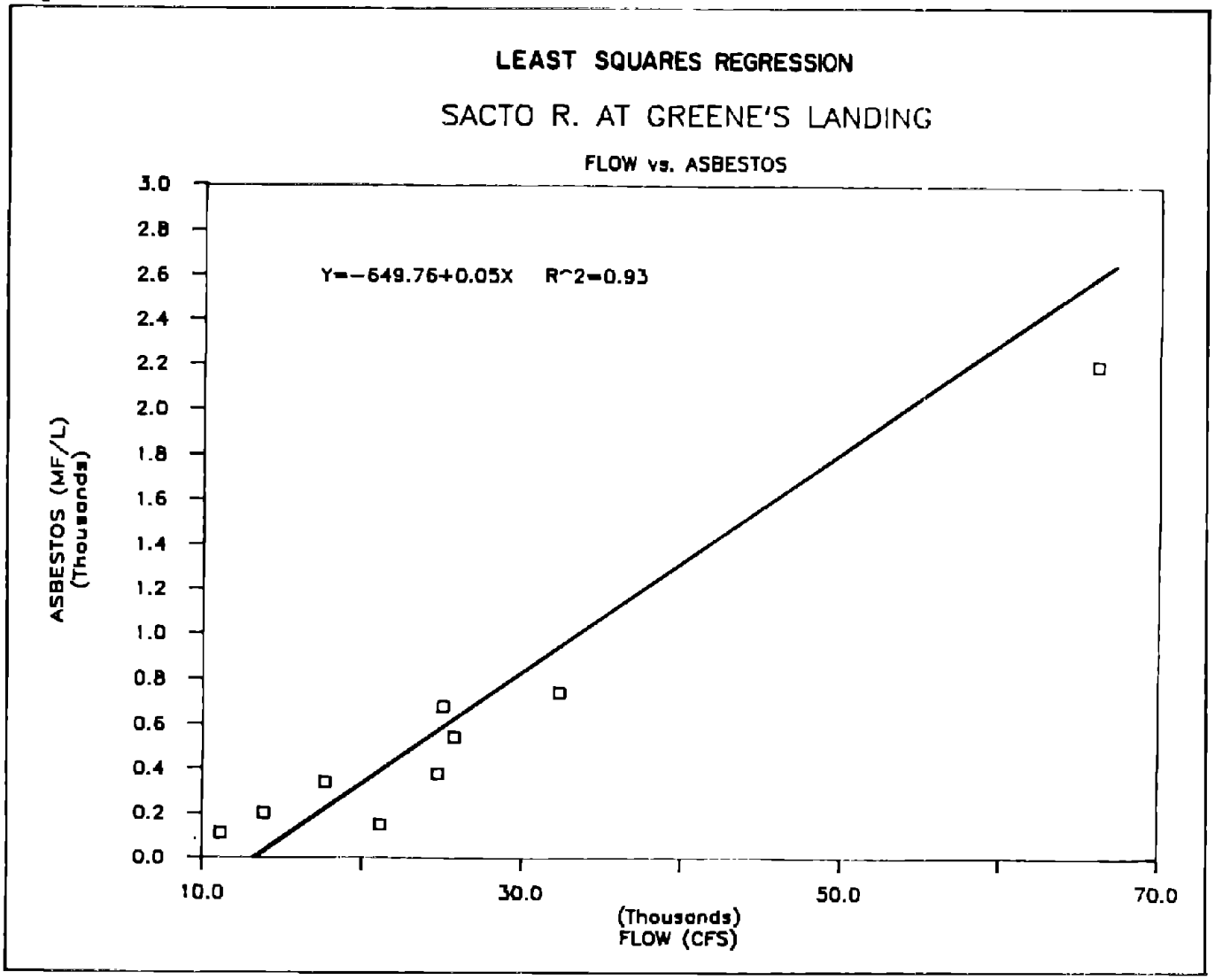


Table 2

EFFECT OF WATER TREATMENT ON ASBESTOS CONCENTRATIONS*

Treatment Plant	Dates Sampled	Asbestos Concentrations (MF/L)** Raw Water	Finished Water	Percent Removal
Penitencia Water Treatment Plant	11/29-30/83	3,000	1.5	99.95
American River Water Treatment Plant	12/6-7/83	890	17	98.09

* Water samples tested were composites of hourly samples taken over a 24-hour period. The Penitencia Water Treatment Plant is a facility of Santa Clara Valley Water District that derives its water from the South Bay Aqueduct of the State Water Project. The American River Water Treatment Plant is operated by the City of Sacramento and is supplied from the American River.
**MF/L = Million Fibers per Liter.

Selenium

Selenium is a trace element required in the diet of humans and other living organisms. However, like many other required nutrients, selenium can be harmful in excessive quantities. The drinking water Maximum Contaminant Level for selenium is 10 ug/L (micrograms per liter, or parts per billion parts water) /21/.

Selenium has recently become a health concern because of widespread publicity regarding harmful effects of selenium on wildlife in Kesterson Reservoir. This reservoir is a facility of the U. S. Bureau of Reclamation San Luis Drain system in the San Joaquin Valley (refer to Figure 2). The selenium concentration in the drain averages about 300 ug/L /21a/. This has raised concern that selenium from San Joaquin Valley agricultural drainage might reach Delta water supplies and present a health hazard.

Because of the concern over selenium levels in Delta water supplies, selenium samples have been collected from various locations within the Delta and its tributaries. Sampling began in July 1984 and is continuing. Table 3 presents the selenium data collected thus far. Selenium concentrations at the 6 locations monitored have not exceeded 1 ug/L, or one-tenth of the recommended MCL for selenium, and most samples had undetectable concentrations. At the concentrations found, the selenium in the water would not comprise a significant proportion of a person's daily selenium intake, as much higher selenium concentrations are present in food /22/.

Selenium levels in the San Joaquin River are discussed further in Chapter 6.

Table 3

SELENIUM DATA SUMMARY

Sampling Location	Date	Selenium Level* (mg/L)
Sacramento River at Greene's Landing	09/05/84	<0.001
	10/04/84	<0.001
	11/08/84	<0.001
	12/05/84	<0.001
Cache Slough at Vallejo Pumping Plant	09/12/84	0.001
	11/15/84	<0.001
	12/06/84	0.001
Lindsey Slough at Hastings Cut	09/12/84	<0.001
	11/15/84	<0.001
	12/06/84	<0.001
San Joaquin River near Vernalis	07/25/84	0.001
	09/27/84	<0.001
	10/25/84	<0.001
	11/29/84	<0.001
	12/12/84	<0.001
Delta-Mendota Canal at Lindeman Road	09/27/84	<0.001
	10/25/84	<0.001
	11/29/84	<0.001
	12/12/84	<0.001
Clifton Court Forebay at Intake	07/25/84	<0.001
	09/27/84	<0.001
	12/12/84	<0.001

* mg/L = milligrams per liter, or parts per million parts water.
<0.001 = selenium concentration less than the 0.001 mg/L detection limit. The drinking water Maximum Contaminant Level for selenium is 0.01 mg/L.

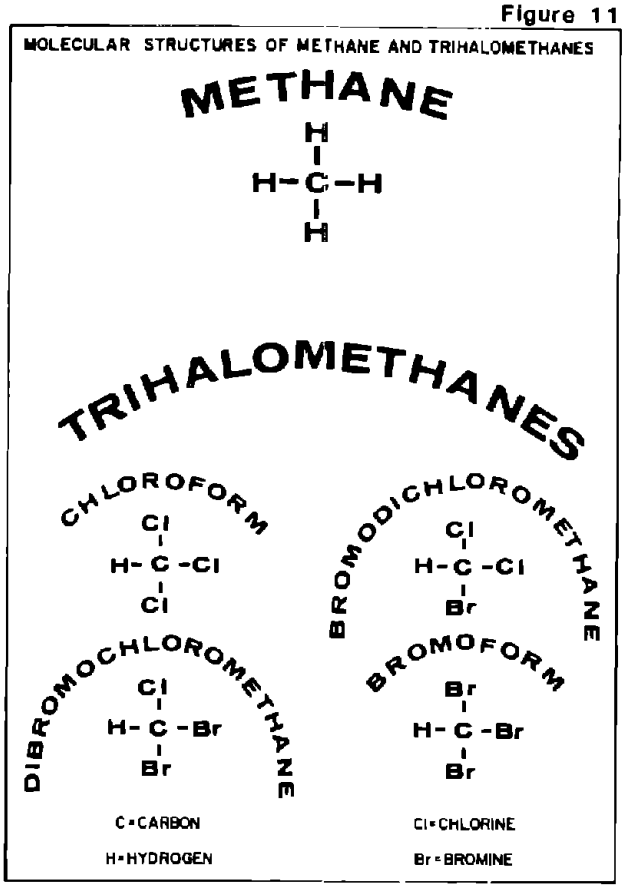
Trihalomethanes

Trihalomethanes (THMs) are a group of compounds that can be formed in drinking water during the process of disinfection with chlorine. Organic substances (humic and fulvic acids) present in the water react in the presence of chlorine to form THMs. The primary source of these naturally occurring organic acids is thought to be decaying vegetation /23/. Where bromides are also present in the water supply, they can enter the reaction to produce bromine-containing THMs /24/. Bromides are salts that are found in significant concentrations in sea water. The four types of THMs typically formed in drinking water are depicted in Figure 11.

Researchers have determined that THMs cause cancer in test animals and may also cause cancer in humans /25,26,27, 28/. The U. S. Environmental Protection Agency has established a Maximum Contaminant Level of 100 ug/L (micrograms per liter, or parts THM per billion parts water) for total trihalomethanes in drinking water. This regulation came into effect for larger drinking water suppliers in 1981 /29/.

Treated drinking water of Delta origin has been analyzed for THMs and has often exceeded the MCL. Currently, suppliers of drinking water of Delta origin are required to provide special treatment to prevent formation of THM levels that exceed the MCL.

Figure 11



Previous monitoring by the Department of Water Resources has demonstrated that waters of the southern Delta are higher in organic THM precursor compounds than some waters tributary to the Delta. Nelson et al. made a similar observation /30/. The effect of lower organic precursor loadings is demonstrated by the fact that water taken from the Sacramento River by the city of Sacramento meets the MCL without special treatment, while water supplied through the State Water Project must be treated to prevent THM formation above the MCL.

The THM forming potential of raw water can be estimated by means of a laboratory analysis known as Total Trihalomethane Formation Potential assay /3,5/. Water samples are collected and chlorinated with a dosage of chlorine in excess of the chlorine demand of the water. The sample is allowed to incubate at 25 degrees Celsius for 7 days, after which the water is analyzed for THMs. The test is designed to estimate the maximum levels of THMs that could be produced from a water supply and, accordingly, does not predict actual concentrations of THMs in finished drinking water. Many factors, including temperature, pH, chlorine contact time, and chlorine dosage, affect actual THM formation in water treatment facilities /4/. The formation potential test is, however, useful for comparing raw water supplies.

Under the current program, monitoring has been conducted to determine THM forming potential of waters of the Delta and its tributary streams. The data are shown in Appendix A and summarized in Figure 12. Data are reported from three locations beginning in March 1982, prior to implementation of the current program in July 1983. These data were collected as an extension of the previous State Water Project Trihalomethane Study to maintain program continuity with the current effort, The stations monitored during the period between the former and current studies were the Sacramento River at Hood (2 miles upstream of the Greene's Landing station), the San Joaquin River near Vernalis, and the Banks Pumping Plant Headworks.

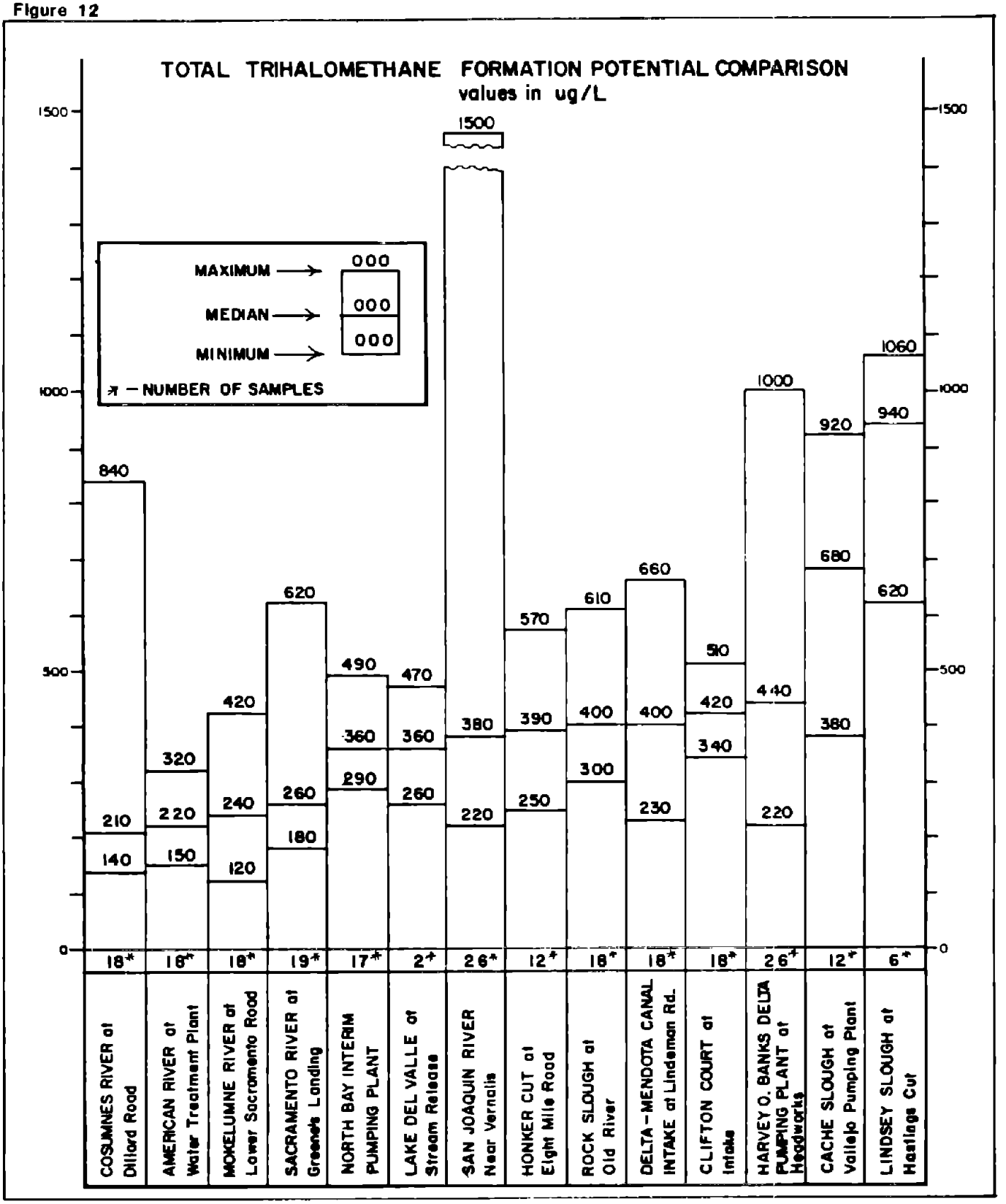
Hood was chosen as a monitoring site when there was active planning for the Peripheral Canal, which would have diverted Sacramento River water at Hood. Since defeat of Senate Bill 200, the legislation that would have enacted the Peripheral Canal and other facilities, the decision was made to relocate the station to Greene's Landing. Water at the Greene's Landing location was believed to be similar in quality to that at Hood, and the Greene's Landing site had been *an* eutablished water quality monitoring station for many years.

Figure 12 depicts minimum, median, and maximum Total Trihalomethane Formation Potentials at the etations monitored in the program. As with the asbestos and sodium analyses, there were insufficient data to determine whether the values are normally distributed, Medians were calculated in preference to means, because the median is a more reliable estimate of central tendency where normal frequency distribution of the data cannot be assured.

Streams tributary to the northern Delta had lower median THM formation potentials than locations in the southern Delta. The Cosumnes, American, Mokelumne, and Sacramento rivers had the lowest medians, while the southern Delta stations (Delta-Mendota Canal Intake, Clifton Court Intake, and Banks Pumping Plant Headworks) had higher median potentials. This finding confirms results of the previous study, which indicated Sacramento River water has lower THM formation potential than water of the southern Delta /1/.

The data indicate median THM formation potentials of Cache and Lindsey slough waters were the highest of the locations monitored. The Lindsey Slough location is particularly significant because a tributary of the slough has recently

Figure 12


TOTAL TRIHALOMETHANE FORMATION POTENTIAL COMPARISON
values in ug/L
MAXIMUM
MEDIAN
MINIMUM
000
000
000
* – NUMBER OF SAMPLES
1500
1000
500
0
840
210
140
18*
COSUMNES RIVER at Dillard Road
320
220
150
18*
AMERICAN RIVER at Water Treatment Plant
420
240
120
18*
MOKELUMNE RIVER at Lower Sacramento Road
620
260
180
19*
SACRAMENTO RIVER at Greene's Landing
490
360
290
17*
NORTH BAY INTERIM PUMPING PLANT
470
360
260
2+
LAKE DEL VALLE at Stream Release
1500
380
220
26*
SAN JOAQUIN RIVER Near Vernalis
570
390
250
12+
HONKER CUT at Eight Mile Road
610
400
300
18*
ROCK SLOUGH at Old River
660
400
230
18*
DELTA–MENDOTA CANAL INTAKE at Lindeman Rd.
510
420
340
18*
CLIFTON COURT at Intake
1000
440
220
26+
HARVEY O. BANKS DELTA PUMPING PLANT at Headworks
920
680
380
12+
CACHE SLOUGH at Vallejo Pumping Plant
1060
940
620
6+
LINDSEY SLOUGH at Hastings Cut

been chosen as the point of diversion for the North Bay Aqueduct (now under construction) of the State Water Project. Water quality routing work done by the Department has indicated that once the North Bay Aqueduct is fully operational, the major source of its water would be the Sacramento River /10a/. On that basis, the conclusion was reached that the water quality of the Sacramento River at Greene's Landing would have a large influence on future Lindsey Slough and North Bay Aqueduct water quality. Therefore, although the present THM formation potential of Lindsey Slough is high, this condition would not reflect expected THM potentials of water taken into the North Bay Aqueduct when it is operational.

Water from the San Joaquin River was higher in median THM formation potential than were streams tributary to the northern Delta, but was similar to waters of the central Delta (Rock Slough, Honker Cut).

Organic THM Precursors in the Delta

THM formation potentials of agricultural drainages were previously measured, as were THM potentials of extracts of Delta soils and of the effluents of waste water treatment plants /1/. Table 4 shows the data. Evidently, Delta soils contain high concentrations of organic THM precursors, particularly the peat soils. The two agricultural drains meaeured had THM potentials greater than were generally observed in Delta waters. However, filtered waste water treatment plant effluent samples had relatively low THM formation potentials. The low THM potentials of the waste water effluents may, however, have reflected the presence in the effluents of ammonia. Ammonia would react with the chlorine to reduce THM formation.

Table 5 shows THM potential data taken from waters of the tidal zone of the Sacramento River, near Chipps Island. Water at this location had a high THM format ion potential.

Based on the limited data that have been collected, soils appear to be the major direct source of organic trihalomethane precursors in Delta waters. The data indicate agricultural drainages may be a significant conduit for the precursors reaching Delta waters, but surface run-off from rainfall would also be important, and perhaps more important, as a source, because greater surface areas would be involved than for agricultural drainages.

Effect of Bromide on Trihalomethane Formation

Although research has not yet been adequate to enable strong conclusions, the U. S. Environmental Protection Agency has indicated concern that the brominated THMs may be more mutagenic than chloroform /29/. The brominated THMs are formed when, in addition to organic precursor compounds, the raw water source also contains bromides. Bromides are ealts that are present in sea water in an approximate concentration of 65 mg/L (parts per million). When chlorine is applied during the disinfection process, bromides enter the THM reaction to form THMs containing combinations of bromine and chlorine (refer to Figure 11).

Bromides in Delta water supplies are of concern primarily because the Delta is hydraulically connected to San Francisco Bay and the Pacific Ocean, and bromides can migrate into the Delta from this source. Other potential sources of bromides include agricultural use of bromine-containing agents and, possibly, bromides from geological formations in the watersheds tributary to the Delta. The bay and ocean are a significant bromide source ; evidence of this is seen in the data reported in Table 5. The Chipps Island sampling site had vary high brominated THM formation potent ial (up to 25,000 ug/L).

Table 4

SOURCES OF ORGANIC TRIHALOMETHANE PRECURSORS

I. Trihalomethane Formation Potential of Delta Soils*

Sample Type	Sampling Date	Maximum Trihalomethane Formation Potential Filtered Soil Extract (ug/Kg) CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total
Composite of Mineral Soils from Northern Delta	12/01/81	27,000				27,000
Composite of Peat Soils from Southern Delta	12/01/81	61,000				61,000

II. Trihalomethane Formation Potential in Agricultural Drainage*

Sampling Location	Sampling Date	Maximum Trihalomethane Formation Potential (ug/L) Unfiltered Sample CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total	Filtered Sample CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total
Natomas Main	10/14/81	270	50	10		330	240	53	13		310
Drain at West	12/30/81	1,500	35			1,500	900	42			940
El Camino Av.	08/21/84	--------No Unfiltered Sample---------					900	58	6		960
Colusa Basin	10/14/81	390	32			420	420	34			450
Drain at	12/30/81	1,100	66	1.6		1,200	710	41	1.4		750
Knight's Lndg.	08/21/84	--------No Unfiltered Sample---------					930	53	6		990

III. Trihalomethane Formation Potential of Waste Water Treatment Plant Effluents*

Treatment Plant	Sampling Date	Maximum Trihalomethane Formation Potential (ug/L) Unfiltered Sample CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total	Filtered Sample CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total
Sacramento Main	10/06/81	860	32			890	98	12			110
Stockton South	10/06/81	520	79	8		610	200	39	18		260
Easterly (City of Vacaville)	10/06/81	760	260			1,000	280	31	5		320

* Blank spaces indicate concentrations below detection limit.

Table 5

TRIHALOMETHANE FORMATION POTENTIAL OF WESTERN DELTA WATERS
(Sacramento River near Chipps Island)

Sample Type	Sampling Date	Maximum Trihalomethane Formation Potential (ug/L)* Unfiltered Sample CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total	Filtered Sample CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total
High Slack Tide											
Surface	11/09/81		34	340	1100	1500		31	310	1300	1600
Deep	11/09/81	7	69	450	24000	25000		19	240	1400	1700
Low Slack Tide											
Surface	11/09/81	--------No Unfiltered Sample---------					5	84	290	720	1100
Deep	11/09/81	--------No Unfiltered Sample---------					3	44	190	500	740
High Slack Tide**											
Surface	01/05/82	590	19			610	550	17			570
Deep	01/05/82	--------No Unfiltered Sample---------					460	9			470

* Blank spaces indicate concentrations below detection limit.
**Sampling was performed at the predicted time of slack tide. Due to high outflow conditions, flow velocity did not reach zero.

Most suppliers of Delta water are using a process known as chloramination for controlling THMs in their finished drinking water. Typically, chlorine is injected into the water and allowed to remain for a contact period sufficient to assure adequate disinfection. Then, ammonia is injected. The ammonia rapidly combines with the free chlorine remaining in the water to form chloramines. Chloramine has considerably weaker disinfection capabilities than free chlorine, but it is sufficient to maintain disinfection in water distribution systems /31/. The major advantage to the use of chloramine is that, in combining with free chlorine, it blocks the THM reaction. Agencies can, therefore, meet the 100 ug/L Maximum Contaminant Level for THMs through this process, while maintaining safe disinfection of the water. A problem with chloramines is that they can interfere with kidney dialysis; for this reason, chloramine use in California has been temporarily suspended, at the request of the State Department of Health Services, until hospitals employing dialysis equipment are able to adequately treat their supplies of dialysis water.

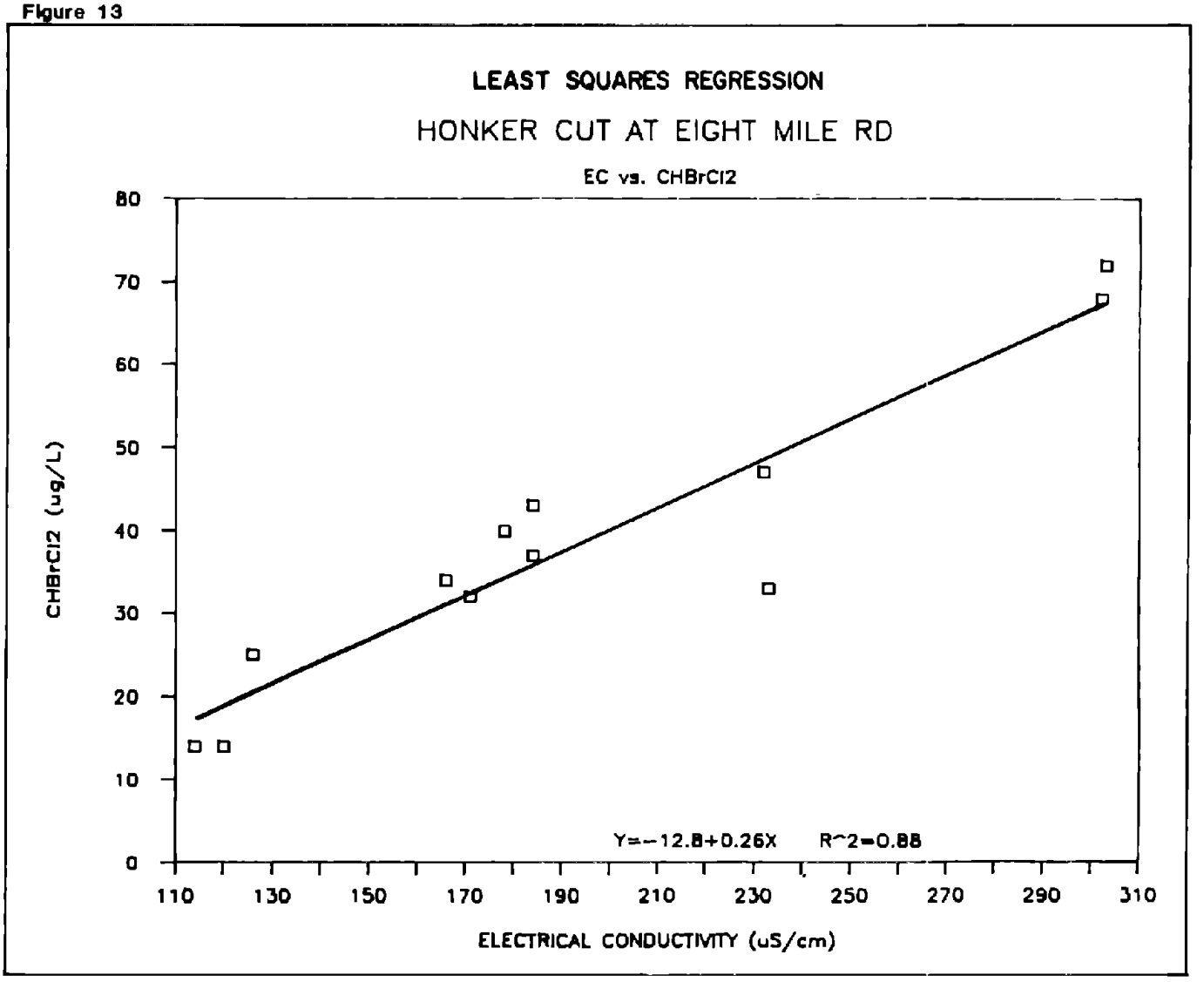
Besides possibly being more mutagenic, brominated methanes have the characteristic of being formed more quickly in drinking water than is chloroform /32/. This characteristic is undesirable in relation to the chloramination process, because during the time chlorine must be in contact with the water before ammonia can be applied, significant levels of the brominated THMs can form. Thus, even though water treated with ammonia can be made to meet the drinking water limit for THMs, a significant proportion of the THMs that are formed in the water are of the brominated type /31/. If, in fact, the brominated THMs are more hazardous than chloroform, the drinking water limit of 100 ug/L (which was established based on chloroform) may not accurately reflect the degree of risk to the exposed population. In the absence of conclusive data, common sense dictates the desirability of taking reasonable actions to avoid or reduce bromide concentrations in raw water supplies and to reduce THM formation in general.

There is a relationship between electrical conductivity and THM formation potentials observed in Delta waters.

The relationship of electrical conductivity to bromodichloromethane concentrations is particularly significant. A regression analysis was performed to determine the best fit of the data with four equation forms. The results are shown in Figures 13 through 16. The linear equation form provided the best fit, with coefficients of determination (r-squared) as high as 0.88. (A coefficient of 1.0 indicates a perfect fit of the data to the equation; a value of 0 indicates no relationship.)

Brominated methane formation potential correlated well with electrical conductivity at the Delta-Mendota Intake, Honker Cut, the San Joaquin River near Vernalis, and Clifton Court Intake

Figure 13



(r-squared = 0.84, 0.88, 0.88, and 0.86, respectively). Correlations for the Sacramento River at Greene's Landing and the Banks Pumping Plant were poor (0.55 and 0.56).

Regression analyses failed to demonstrate a satisfactory correlation of total THM formation potential to flow, color, turbidity, or electrical conductivity. However, a positive relationship was shown between trihalomethane formation potential (THMFP) and total organic carbon (TOC). Of four equation forms, the best-fit equation was $THMFP = 171(TOC)^{0.718}$, ($R^2 = 0.78$). While the correlation was not sufficiently strong to enable accurate prediction of THM potential from total organic carbon analyses, the relationship is interesting and deserves closer examination.

Figure 14

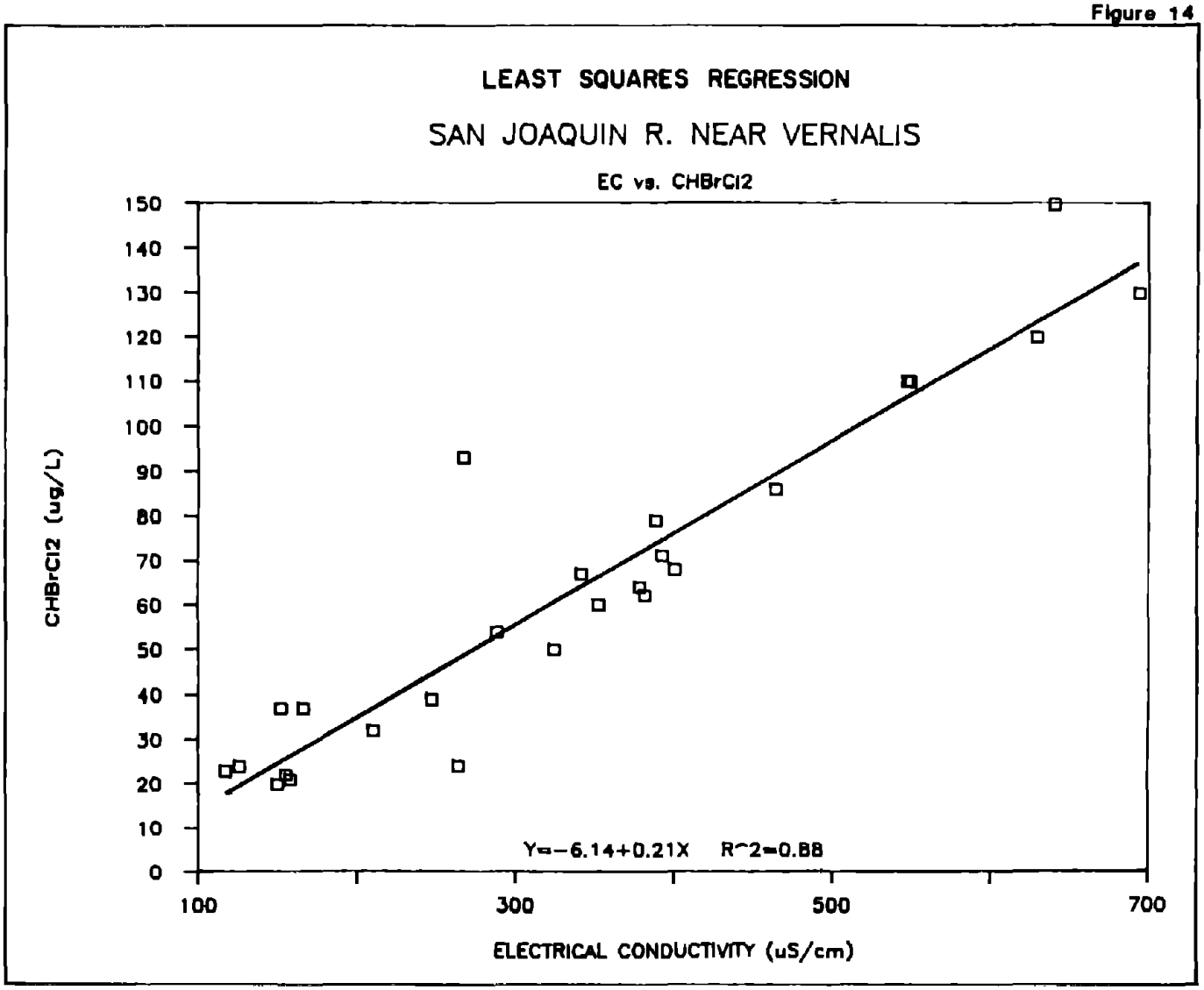


Figure 16

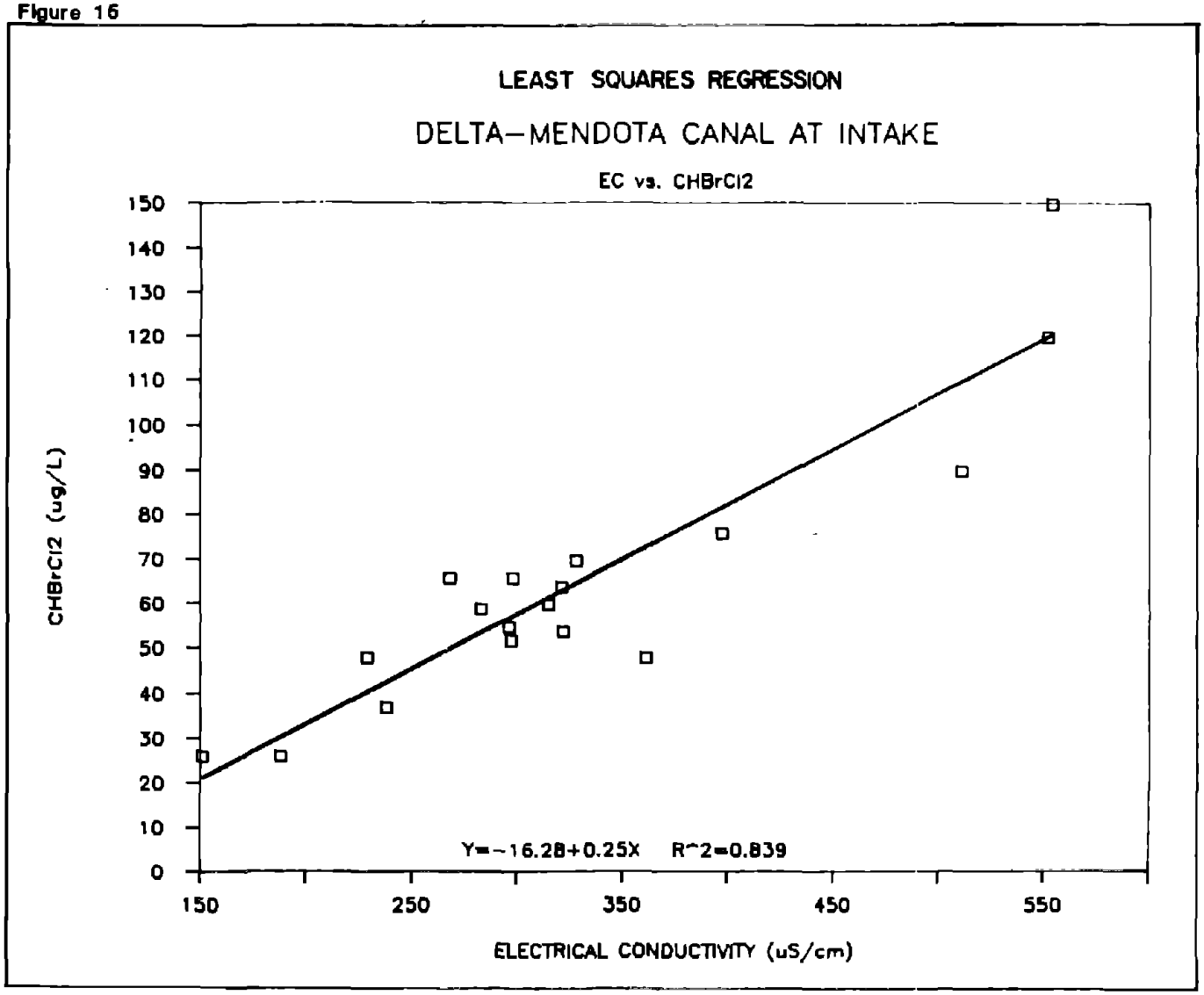
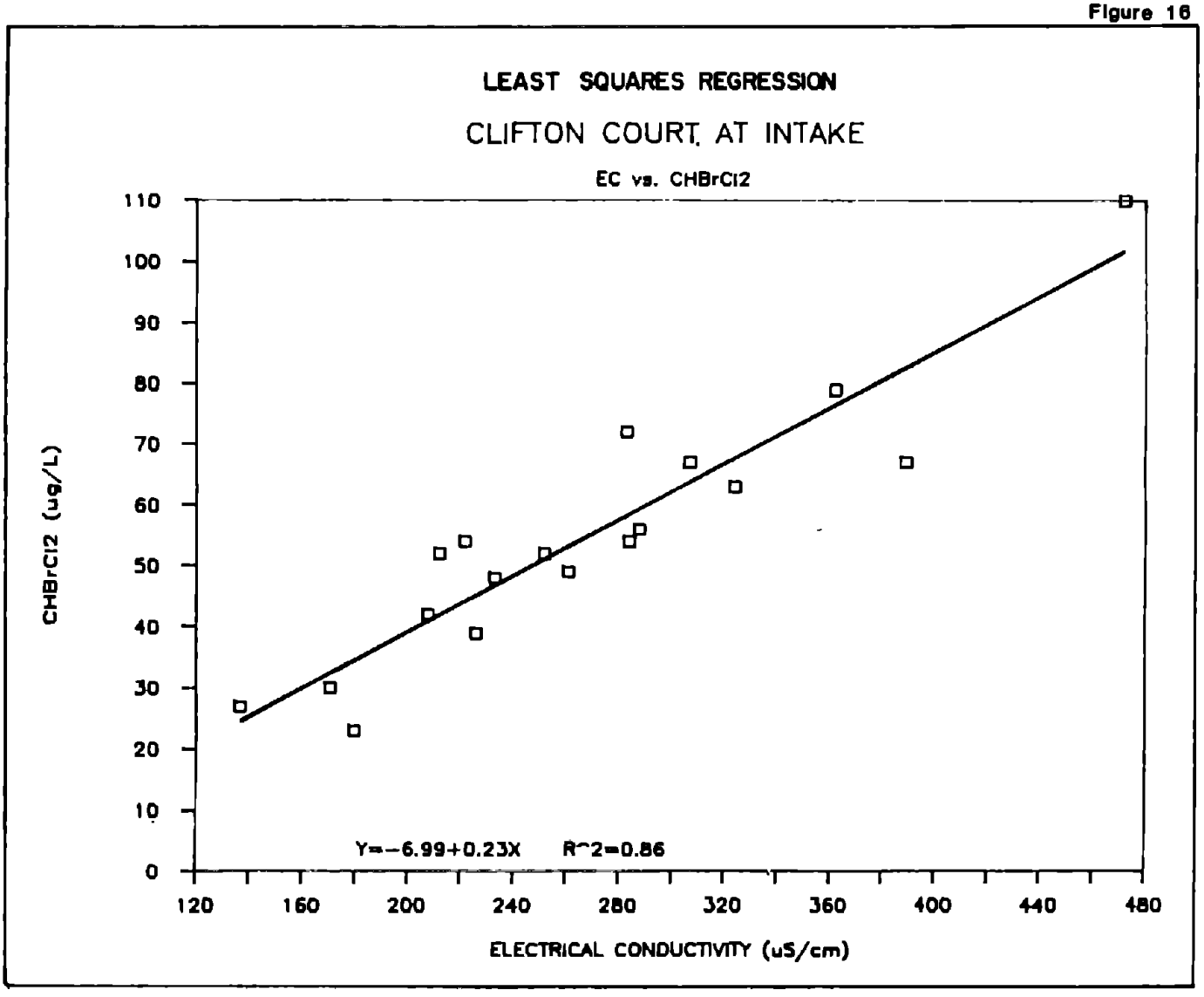

LEAST SQUARES REGRESSION
DELTA–MENDOTA CANAL AT INTAKE
EC vs. CHBrCl2
CHBrCl2 (ug/L)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Y=-16.28+0.25X R^2=0.839
150
250
350
450
550
ELECTRICAL CONDUCTIVITY (uS/cm)

Figure 16


LEAST SQUARES REGRESSION
CLIFTON COURT AT INTAKE
EC vs. CHBrCl2
CHBrCl2 (ug/L)
110
100
90
80
70
60
50
40
30
20
10
0
Y=-6.99+0.23X R^2=0.86
120
160
200
240
280
320
360
400
440
480
ELECTRICAL CONDUCTIVITY (uS/cm)

Organic Pollutants

The Priority Pollutants are a group of 129 toxic elements and organic compounds identified by the Environmental Protection Agency as being of special environmental concern, based on amounts used, environmental behavior, and other factors /33,34/. The chemicals on the Priority Pollutants list comprise about 65 diverse classes of compounds, which cannot be analyzed by any one method. The EPA devoted great effort to developing analytical methods for the Priority Pollutante.

Perspectives on organic chemical pollution are changing rapidly, and this list of chemicals , established some years ago, may not now be the pollutants of highest priority for monitoring and control. The justification for monitoring organic Priority Pollutants is that the methods devised to identify them will also detect a wide range of other chemical compounds. Consequently , this monitoring is a broad based scan for a wide variety of potential organic chemical pollutants.

On three occasions during this 18-month study, the regular stations in the program were sampled, and the samples analyzed for the organic Priority Pollutants. Additionally, special low-level analyses were performed for certain chemical agents of special concern. The analyses were done according to testing protocols developed by the U. S. Environmental Protection Agency. Details of methodology and analytical detection limits are presented in Appendix B.

The data from this monitoring are summarized in Tables 6, 7, and 8. Generally, only low levels of organic chemicals were detected. Various phthalate compounds were observed, however. These agents are widely used in manufacturing, particularly of plastics. The estimated annual production of phthalate esters is 900 million pounds /35/. Test data have indicated some of the phthalate compounds may be mutagenic and are capable of bioconcentration /36/.

The widespread detection of phthalate esters could indicate that phthalates affect a large area of the Delta, but could also indicate sample contamination. Contact with plastic during sampling or analysis could have contaminated the samples. The possibility of contamination has been seriously considered ; however, the sampling , sample handling, and analytical procedures used were designed to minimize the possibility of such contamination (see Chapter 4). Krasner, et al. found Di-n-butyl phthalate and Diethyl phthalate in water from the State Water Project. The maximum concentration observed was 1.7 ug/L /37/. Therefore, the compounds detected in this program may reflect actual presence in Delta waters. Further monitoring will be required to verify their presence. No drinking water criteria have been established for phthalates.

Pesticides were observed at various places, but in very low concentrations; all were below 1 ug/L.

Trichloroethylene (TCE) and tetrachloroethylene were found in a sample taken at the Banks Pumping Plant on October 26, 1983. The concentrations were 3.1 ug/L for TCE and 0.3 ug/L for tetrachloroethylene. A follow-up sample taken in January 1984 showed no TCE present. TCE was also observed in water samples from the American and Sacramento rivers on February 7, 1984, at concentrations of 0.4 and 0.1 ug/L, respectively. The State Department of Health Services has recowended an "action level" of 5 ug/L for trichloroethylene and 4 ug/L for tetrachloroethylene in drinking water . These are advisory levels intended to warn that water exceeding action levels of pollutants should not be consumed by humans on a continuous basis /38/.

Besides the compounds already mentioned, mass spectrographic data were used to tentatively identify a number of other chemicals in project samples. These compounds, which are mostly related to benzene, may be the result of petrochemical pollution, but can also be from naturally occurring substances similar to the organic trihalomethane precursors discussed earlier. The significance of these compounds is, therefore, unknown.

The absence of significant concentrations of other synthetic organic compounds in Delta water supplies is confirmed by an organics survey of Cache Slough water /39/ and by surveys of Delta and State Water Project waters by Davis, et al. /40/ of the Metropolitan Water District and by the Santa Clara Valley Water District /41/.

Although the limited data collected in this program are reassuring in that gross synthetic organic chemical pollution of Delta water supplies was not demonstrated, the work accomplished to date was only a survey, and considerable additional effort will be required to develop a database adequate for strong conclusions.

Table 6

SYNTHETIC ORGANIC POLLUTANTS DATA, OCTOBER 1983*
(Concentrations in Micrograms per Liter, or Parts per Billion Parts Water)

	Am.R. @ WTP	Banks PP @ Hdwks.	Clif.Ct. @ Intake	Cosum. R. @Dill.Rd.	DMC Intake @ Linde.Rd.	Honker Cut @ 8-Mi.Rd.	LakeDelValle Stream Rel.	Mallard Sl@P.P.	Mok.R. @Woodbr.	No.Bay P.P.	Rock Sl. @ Old R.	Sac.R. @Grns.	SanJoaq. nr.Vern.
Compounds Detected													
trichloroethylene		3.1											
tetrachloroethylene		0.3											
di-n-butyl phthalate	3	5	10	6	5	5	3	5		3			
bis(2-ethyl hexyl) phthalate	270					220				230			
Compounds Tentatively Identified**													
	Retention Time (Minutes)												
C3 benzene	3.5	2	0.8	3	1	5	3	0.6	1	0.3	0.8	0.1	0.3	0.9
C3 benzene	4.1	0.6	3	2	0.2	8	0.6	0.1	0.5	0.1	0.3	0.2	0.1	
C3 benzene	4.2	0.4	0.3	1	0.4		0.9	0.2	0.6		0.2		0.1	0.2
C3 benzene	5.8	1	0.4	1	0.7	0.9	4	0.9	6		0.3	0.1		0.7
Unknown C16 H16	11.9	2	0.9	2	2	0.9	3	0.5	2	0.5	0.8	0.2	0.5	0.7
Unknown (C8 H8)2	12.0	10	7	20	10	6	20	2	20	0.8	1	0.7	0.9	4
Unknown C16 H16	12.2	5	3	8	5	2	9	2	2		3	0.7	2	2
Unknown C16 H16	16.7	100			90	40	20		5	2		4	2	10
Unknown C16 H16	17.3	10	9	1	50	3			40	3	3	2	2	10
di-n-octyl adipate	16.1					210				450				

* Samples were collected on October 25 and 26, 1983. Blank spaces indicate compound not detected.

** Tentative identifications based on computer match of mass spectrographic data.

Table 7

SYNTHETIC ORGANIC POLLUTANTS DATA, NOVEMBER 1983 AND FEBRUARY 1984*
(Concentrations in Micrograms per Liter, or Parts per Billion Parts Water)

	Am.R. @ WTP	Banks PP @ Hdwks.	Clif.Ct. @ Intake	Cosum. R. @Dill.Rd.	DMC Intake @ Linde.Rd.	Honker Cut @ 8-Mi.Rd.	Mok.R. @Woodbr.	Natomas Main Drain (Ag.)	No.Bay P.P.	Rock Sl. @ Old R.	Sac.R. @Grne.	SanJoaq. nr.Vern.
Compounds Detected												
Volatile												
1,1,1-trichloroethane											0.1	
trichloroethylene	0.4										0.1	
Extractable Base/Neutral												
diethyl phthalate						0.2	0.2					
di-n-butyl phthalate		0.2	0.8	0.7	0.3		0.5			0.6		0.5
di-n-octyl phthalate				0.7		1.1						1.3
bis(2-ethylhexyl) phthalate	4.4	0.9	0.5	46	0.1	5	6.8			83	19	43
Organochlorine Pesticides												
a-BHC								2				
Organophosphorus Pesticides												
Carbofuran								0.4				
Malathion								0.01				
Parathion										0.002		
Diazinon									0.01	0.003		
Guthion										0.020		
Compounds Tentatively Identified**												
Freon 113					1.0							
3-methyl-eicosane (C21 H44)									1			
2,4-dimethyl pentane (C7 H16)									0.5			
hexanedioic acid dioctyl ester (C22 H42 O4)		1		100							0.3	
1,1,1-trimethyl-cyclo-pentane (C8 H16)				0.8								

Table 7 (continued)

SYNTHETIC ORGANIC POLLUTANTS DATA, NOVEMBER 1983 AND FEBRUARY 1984*
(Concentrations in Micrograms per Liter, or Parts per Billion Parts Water)

	Am.R. @ WTP	Banks PP @ Hdwks.	Clif.Ct. @ Intake	Cosum. R. @Dill.Rd.	DMC Intake @ Linde.Rd.	Honker Cut @ B-Mi.Rd.	Mok.R. @Woodbr.	Natomas Main Drain (Ag.)	No.Bay P.P.	Rock Sl. @ Old R.	Sac.R. @Grns.	SanJoaq. nr.Vern.
hexacosane (C26 H54)				0.6								
bis(2-ethylhexylester), hexanedioic acid (C22 H42 O4)												60
1-cyclohexyl-2-N-decylodecan (C28 H56)												1
tetradecanoic acid (C14 H28 O2)+ 2-propyl-1-heptanol (C10 H22 O)		1										
nonadecanol (C19 H40 O)			1									
4,8,12-trimethyl-3,7,11-tridecatrienitrile (C16 H25 N)		2										
Unknown phthalate (R.T. 16.4)						6						
(R.T. 17.3)												3
(R.T. 17.4)				4								
(R.T. 18.3)						7						
(R.T. 18.8)				0.9								4
(R.T. 19.5)						4						
Other unknown phthalates							0.5				2	
Unknown hydrocarbons									0.5	0.9		

* Natomas Main Drain was sampled on November 15, 1983. Other samples were collected on February 7 and 8, 1984.

** Tentative identifications based on computer match of mass spectrographic data.

Table 8

SYNTHETIC ORGANIC POLLUTANTS DATA, SEPTEMBER 1984*
(Concentrations in Micrograms per Liter, or Parts per Billion Parts Water)

Compounds Detected	Am.R. @ WTP	Banks PP @ Hdwks.	Clif.Ct. @ Intake	Cache Sl. @ P.P.	Cosum. R. @Dill.Rd.	DMC Intake @ Linde.Rd.	Honker Cut @ 8-Mi.Rd.	Lindsey Sl. @ Hast. Ct.	Mok.R. @Woodbr.	No.Bay P.P.	Rock Sl. @ Old R.	Sac.R. @Grns.	SanJoaq. nr.Vern.
d-BHC			0.002				0.006	0.002	0.002	0.002	0.002		
Diazinon		0.003	0.004			0.004						0.004	0.037
Dimethoate		0.006	0.013			0.013							
Endosulfan II							0.004						
Ethion								0.004					0.006
Methyl Parathion		0.015		0.027									
trichloroethylene	0.2												

* Samples collected September 19 and 20, 1984. Blank spaces indicate compound not detected.

Pesticides

In 1983, the most recent year for which data are available, 81 million pounds of pesticides were reported used in California /42/. This figure does not include unrestricted pesticides applied by non-licensed persons, which may be about 40 percent of the total reported /43/. If this estimate is accurate, about 110 million pounds of pesticides were applied in the State during 1983.

Pesticide use is generally much more responsible today than was the case some years ago. The Environmental Protection Agency regulates pesticide use, and pesticides to be used in California must also be accepted by the State Department of Food and Agriculture.

Although the system for regulating pesticides in California is stringent, applications of the magnitude experienced in this State necessitate concern for protecting water supplies. The Delta water supplies are particularly vulnerable, because a large portion of the State's agricultural watersheds is tributary to the Delta.

The significance of pesticide applications led to a recommendation in July 1984 by the program's Technical Advisory Group for monitoring specific pesticides in the Delta and to accomplish as much as possible in the remaining time of the study. The plan was to examine pesticide use data to determine which pesticides are most used in watersheds tributary to the Delta and to determine when and where they are applied. Then data would be reviewed to determine the environmental behavior of the most-used chemicals. A priority list of pesticides would be generated to reflect pesticides of highest use, which also would be most likely found in drinking water supplies.

The most-used pesticides in each of the watersheds tributary to the Delta were identified from 1982 pesticide use data, the most current then available /44/. Table 9 summarizes known information about the environmental behavior of the most-used agents. Table 10 is the list of target chemicals for monitoring during fall 1984, selected based on timing of application, persistence, water solubility, quantity applied, and analytical capability. The selection was intended to maximize the probability of detecting the compounds if they are reaching Delta water supplies in significant amounts.

During September 1984, monitoring was conducted at the regular sampling stations for the pesticides shown on Table 10. Results are shown in Table 11. Few pesticides were detected, and concentrations were below 1 ug/L (one part per billion). These data give preliminary assurance of the quality of Delta water supplies, but this sampling represents only one attempt. Because spring and early summer are the most significant periods from the standpoint of pesticide applications, further work would have to be done to enable firm conclusions,

A pesticide survey by the city of Vallejo on its Cache Slough water source indicated no pesticides in concentrations exceeding 1 ug/L /45/. This survey included pesticides regulated under State drinking water criteria, and did not include all pesticides used in California /21/. The Metropolitan Water District organics survey also failed to identify significant concentrations of pesticides in State Water Project water taken from the southern Delta /40/. Similar to the survey by the city of Vallejo, this survey was limited to pesticides regulated under State drinking water criteria.

Table 9

PESTICIDE DATA SUMMARY

Chemical Name	[1] Halflife in Water (Days)	[2] pKa 20°C	[3] AB 1803	[4] Type	[5] Carc. Mut. Ter.	[6] Solub.	[7] Total lbs Applied (1000s)	[8] Appl. Timing	[9] Fish Tissues	[10] Prop. Target Comp.
Acephate (Orthene-R)	30e	0.14	+	I		650,000	327	3-9		*
Alachlor	70e	2.7	+	H		242	61	10-4		*
Alkylaryl Poly (oxyethylene) Glycol				C			0.7	1-12		
Aromatic Petroleum Solvents				C			1,253	2-9		
Atrazine		3.8	+	H		33	387	10-4		*
Azinphosmethyl (Guthion)	<30e	3.8		I		33	544	4-8		*
Barban				H			30	2-4		
Benomyl	30e	4	+	FN		4	130	1-12		
Bentazon, Sodium Salt		2.5		H		500	125	2-9		*
Bromoxynil Octanoate				H			179	3-6		
Captafol (Difolatan)	<1	4.4		FN		1.4	121	6-10		
Captan	<1	4.1	+	FN		3	746	1-8		
Carbaryl (Sevin)	8	3.3	+	I		40	793	4-9		
Carbofuran (Temik)	8	2.4	+	I		700	187	4-6		
Carbon Tetrachloride	<1	2.6		C		800	59	1-12		
2-Chloro-1-(S-Ethoxy-4-Nitro-phenoxy)-4-(Trifluoromethyl) Benzene				C?			16	1-12		
S-(4-Chlorophenyl methyl) Diethylcarbamothioate				C			675	1-12		*
Chloropicrin		2.0	+	FM		2,000	1,430	1-12		
Chlorothalonil (Daconil)	7e	4.7	+	FN	+	0.6	350	6-9		*
Chlorpyrifos (Dursban)	<30	4.1	+	I		0.3	240	2-5	+	
2,4-D, Alkanolamine Salts	30	1.5		H		10,000	161	3-9		*
2,4-D, Butoxyethanol Ester				H			52	3-9		
2,4-D, Dimethylamine Salt	30	0		H		100,000	<1	3-9		
2,4-D, Isooctyl Ester	3.8			H		10	17	3-9		
2,4-D, Propyleneglycol-butylether Ester				H			28	3-9		
D-D Mixture (1,2-dichloro propane; 1,3-dichloro propane)	70-365	1.9	+	I		2,700	13,788	4-6 9-12		*
DEF	94e	>3.8		G		<10	881	6-9		*
Diazinon	<30	3.3	+	I		40	334	1-10	+	*
2,6-Dichloro-4-Nitroaniline				C?			234	1-12		*
Dicofol (Kelthane)	1	4.6	+	I	+	0.8	479	5-10		*
Difenzoquat				H			44	2-4		
Dimethoate	56	1.2	+	I	-	25,000	396	2-10		*
Dimethyltetrachlorotere phthalate (Dacthal)		4.7	+	H		0.5	267	11-4	+	*
Disulfoton (Disyston)	70e	3.4	+	I		25	255	2-9		*
Diuron	60	3.3	+	H		42	441	10-5		*
DNBP (Dinoseb)		3.2	+	H		50	900	11-2		*

Table 9 (continued)

PESTICIDE DATA SUMMARY

Chemical Name	[1] Halflife in Water (Days)	[2] pOct 20°C	[3] AB 1803	[4] Type	[5] Carc. Mut. Ter.	[6] Solub.	[7] Total lbs Applied (1000s)	[8] Appl. Timing	[9] Fish Tissues	[10] Prop. Target Comp.
Endosulfan	14	5.2	+	I		0.1	353	6-8	+	
EPTAM	14e	2.6		H		370	42	10-3		
Ethion	28	4		I		2	44	11-7		
Ethylene Dibromide	10	4.0	+	FM		4.3	874	5-7		*
Ethylenebis (Dithiocarbamic Acid) Manganese Salt with Zinc Ion							270	1-12		
Folex				G			207	6-9		
Glyphosate, Isopropylamine Salt				H			228	1-12		
Imidan	<30e	2.83		I		25	153	4-9		
IPC (Isopropyl-carbanilate)				H			68	1-12		
Linuron (Lorox)				H			20	1-9		
Malathion	7	2.89		I	-	145	523	1-12		*
Maleic Hydrazide, Diethanolamine Salt (Regulox 36)				G	-		50	6-9		
Maneb	<90e	<3	+	FN	+	<100	585	2-9		*
MCPA, Butoxyethanol Ester	30	2		H		800	14	3-6		
MCPA, Dimethylamine Salt	30	2		H		800	553	3-6		
MCPA, Isoctyl Ester	30	2		H		800	11	3-6		
Methamidophos	170	0.8	+	I		90,000	349	3-9		*
Methiadathion (Supracide)	<30e			I			305	3-9		
Methomyl	<30e	0.9	+	I		58,000	681	6-9		*
Methylisothiocyanate		3.1		C?		75	24	1-12		
Methyl Bromide	30	1.4	+	FM		13,400	6,289	1-12		*
Methyl Parathion	14	3.2		I		57	248	3-9		*
Molinate (Ordram)	14			H			1,500	4-6		
Paraquat Dichloride	<30e	0	+	H		1,000,000	572	3-9		*
Parathion, ethyl	14	3.81	+	I		24	663	1-12		*
Phorate	>180e	3.5	+	I		50	197	3-6		
Phosalone	7e			I			40	3-9		
Polyram				FN			30	3-9		
Propanil	30e	2.7		H		225	84	3-5		
Propergite (Omite)	14	3.8		I		10	1,323	4-8		
Simazine	90e	4	+	H		5	241	10-3		*
Toxaphene	>10yr	4		I	+	3	376	4-9	+	*
Trifluralin	2	4.6		H		0.6	165	10-3		*
Xylene	1e	2.70-3.20		C		35-198	1,500	5-9		*
Ziram	<90e	3.1	+	FN		65	363	3-9		

Table 9 (continued)

PESTICIDE DATA SUMMARY

Footnotes:

[1] e = estimated

[2] pOct = logarithm of octanol partitioning coefficient. Data were either derived experimentally or calculated from aqueous solubility.

[3] + indicates compound appears on list of pesticides generated by State Department of Health Services in connection with Assembly Bill 1803.

[4] Pesticide type: C = Carrier; G = Growth Inhibitor; FM = Fumigant; H = Herbicide; FN = Fungicide; I = Insecticide

[5] + = Positive test results for carcinogenicity, mutagenicity, or teratogenicity;
- = Negative test results.

[6] Aqueous solubility, mg/L, generally at 20°C.

[7] Total pounds applied in 1982, as reported by State Department of Food and Agriculture.

[8] Months during which most usage occurs; i.e., 3-9 = March through September.

[9] + indicates compound observed in fish tissue, reported in 1983 Toxic Substances Monitoring Program; 1983 Data Report, California Department of Fish and Game.

[10] * = Proposed target compound for September, October, November, December 1984 monitoring.

Table 10

TARGET PESTICIDES FOR SPECIFIC SAMPLING LOCATIONS*

Target Compounds	Am.R. @ WTP	Banks P.P.	Cache Sl. @V.P.P.	Cosum. R. @Dill.Rd.	Lindsey Sl. @Hast.Ct.	Mok.R. @Woodbr.	No.Bay P.P.	Sac.R. @Grna.	SanJoaq. nr.Vern.
Alachlor	x	x	x	x	x	x	x	x	x
Atrazine	x	x	x	x	x	x	x	x	x
Azinphosmethyl (Guthion)	x	x	x	x	x	x	x	x	x
Bentazon	x	x	x	x	x				x
Chlorothalonil	x	x	x	x	x	x	x	x	x
2,4-D, Alkanolamine Salts	x	x	x	x	x	x	x	x	x
D-D Mixture	x	x	x	x	x	x	x	x	x
trichloropropanes**	x	x	x	x	x	x	x	x	x
DEF		x							
Diazinon		x	x	x	x	x	x	x	x
2,6-Dichloro-4-Nitroaniline	x	x	x	x	x	x	x	x	x
Dicofol	x	x	x	x	x	x	x	x	x
Dimethoate	x	x	x	x	x	x	x	x	x
Dimethyl Tetrachlorotere-phthalate (Dacthal)		x	x		x			x	
DNBP (Dinosab)	x	x	x	x	x	x	x	x	x
Disulfoton	x	x	x	x	x	x	x	x	x
Diuron		x	x	x	x	x	x	x	x
Ethylene Dibromide	x	x	x	x	x	x	x	x	x
Malathion	x	x	x	x	x	x	x	x	x
Methyl Bromide	x	x	x	x	x	x	x	x	x
Methyl Parathion	x	x	x	x	x	x	x	x	x
Parathion	x	x	x	x	x	x	x	x	x
Simazine	x	x	x	x	x	x	x	x	x
Toxaphene	x	x	x	x	x	x	x	x	x
Trifluralin						x			x
Xylene	x	x	x	x	x	x	x	x	x

* List of target compounds for monitoring Delta tributaries from September through December 1984.
x = Compound used in watershed tributary to sampling station.
**Contaminant contained in D-D Mixture.

Table 11

SPECIFIC PESTICIDE MONITORING

	Concentrations Detected at Stations Monitored (ug/L)*								
	Am.R. @ WTP	Banks P.P.	Cache Sl. @V.P.P.	Cosum. R. @Dill.Rd.	Lindsey Sl. @Hast.Ct.	Mok.R. @Woodbr.	No.Bay P.P.	Sac.R. @Grns.	SanJoaq. nr.Vern.
I. Target Compounds Detected									
Atrazine/Simazine			0.21		0.22				
Dacthal									0.02
Methyl Parathion			0.06						
Parathion			0.05						
2,4-D			0.08						
II. Other Compounds Detected									
Chloropropham									
Chloropyrifos			0.17		0.01				
Monocrotophos			0.02						
PCP			0.12						
Unknowns			0.04		0.02				
Trichloroethylene	0.2								
Sampling Date (1984)	10/4	9/27	9/12	10/4	9/12	10/4	9/12	10/4	10/4

* Blank spaces indicate compound not detected.

The overall quality of the San Joaquin River and its relationship to Delta water quality is of great interest as Californian8 plan future water supply alternatives. The data indicate that, from the point of view of peeticides, the San Joaquin River is not obviously of lesser quality than other tributaries to the Delta. Although the San Joaquin Valley contain6 over 13,000 square miles of land surface, much of which is in agricultural production, neither surface runoff nor subsurface drainage is considered a major pathway for pesticides reaching San Joaquin Valley waterways. Evidence of substantial runoff is lacking, and the soils of the valley discourage downward movement of peeticides /46/. In addition, the data do not indicate that the San Joaquin River is a major source of selenium in Delta water supplies.

There are, however, data demonstrating that the San Joaquin River is of poorer mineral quality than other Delta tributaries. Table 12 summarizes data on total dissolved solids concentrations (TDS) in the San Joaquin River near Vernal is, in the Sacramento River at Greene's Landing, at the Banks Pumping Plant, and at the California Aqueduct inlet to and outlet from O'Neill Forebay. The TDS of the lower San Joaquin River averaged 404 parts per million over the lo-year period January 1974 through December 1983 (the most recent data available). During a similar period, TDS in the lower Sacramento River averaged only 104 parts per million.

The State Water Project quality objectives are shown in Table 13. The TDS concentration in the San Joaquin River would exceed the 220 parts per million TDS IO-year objective. From this

Table 12

TOTAL DISSOLVED SOLIDS COMPARISON*
(10-Year Average)

Station	Total Dissolved Solids (mg/L)
Sacramento River at Greene's Landing	104
San Joaquin River near Vernalis	404
Banks Pumping Plant	233
California Aqueduct Inlet to O'Neill Forebay	231
California Aqueduct Outlet from O'Neill Forebay	240

* For January 1974 through December 1983. Total dissolved solids concentrations were derived through correlation with continuous electrical conductivity recording6 at each of the stations listed.

Table 13

STATE WATER PROJECT QUALITY OBJECTIVES*

Parameter	Monthly Average	10-Year Average	Maximum At Any Time
Total Dissolved Solids (mg/L)	440	220	
Total Hardness (mg/L)	180	110	
Chlorides (mg/L)	110	55	
Sulfates (mg/L)	110	20	
Boron	0.6	---	
Sodium (%)	50	40	
Fluoride (mg/L)			1.5
Lead (mg/L)			0.1
Selenium (mg/L)			0.05
Hexavalent Chromium (mg/L)			0.05
Arsenic (mg/L)			0.05
Irm and Manganese (sum - mg/L)			0.03
Magnesium (mg/L)			125
Copper (mg/L)			3.0
Zinc (mg/L)			15
Phenol (mg/L)			0.001

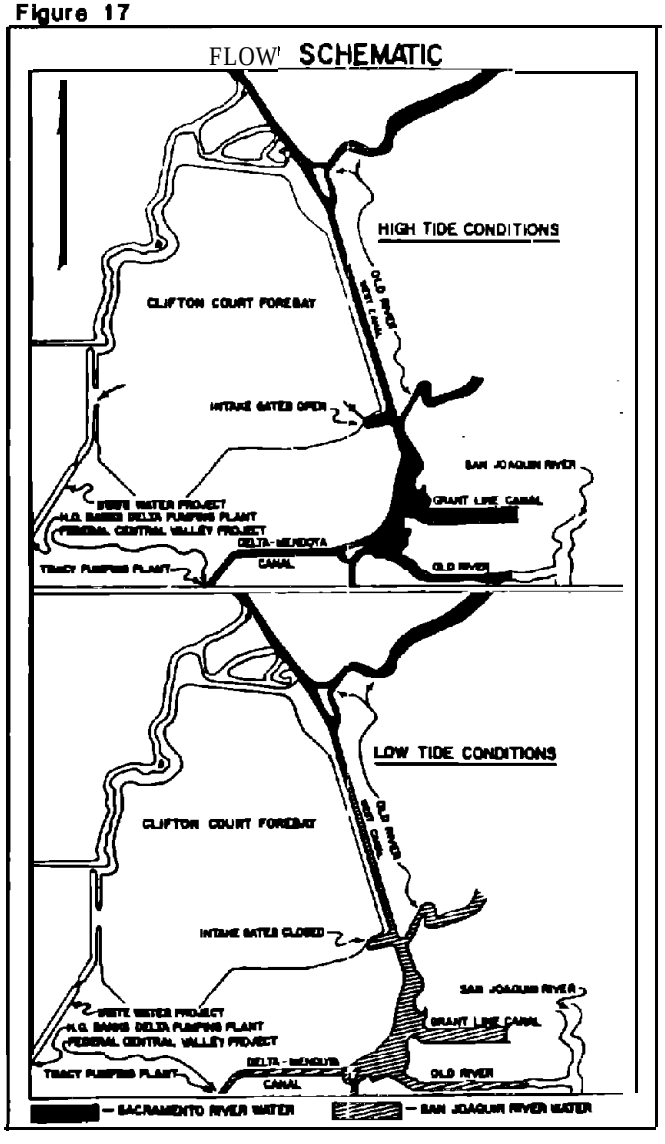
* As stated in Article 19 of "Standard Provisions for Water Supply Contract".

standpoint, San Joaquin River water would be considered less desirable than Sacramento River water as a supply for the State Water Project. The State Water Project minimizes the influence of the San Joaquin River by its method of taking water from Old River, in the southern Delta, into Clifton Court Forebay, a small reservoir upstream of the Banks Pumping Plant. Figure 17 is a schematic representation of the typical flow configuration. Water is drawn through control gates into Clifton Court from Old River during high tides, when mineral quality of the wate. is at its best. This is because Sacramento River flow tends to push the more saline San Joaquin River water south of the Clifton Court point of intake. During low tides when San Joaquin River water is able to flow as far north as Clifton Court, the control gates are closed. Operation of the project in this manner results in selectively taking water that is mostly of Sacramento River origin.

During the 1974 through 1983 period, the average TDS at Banks Pumping Plant was 233 parts per million, as opposed to the 404 parts per million measured at the San Joaquin River near Vernalis (see Table 12). Water taken into the State Water Project contained higher salt levels than were found in the Sacramento River (104 parts per million). The increase is probably due to a combination of agricultural drainage from Delta islands, mixing of salty bay water with the water supplies of the Delta, and possibly some mixing of San Joaquin River water.

The Federal Central Valley Project also takes water from Old River in the southern Delta. Because the Federal project has no holding reservoir (such as Clifton Court), its water exports typically contain a higher percentage of San Joaquin River water than do State Water Project exports. Although most of the Central Valley Project water is for agr icul tural use, a portion of this water mixes with State Water Project

Figure 17



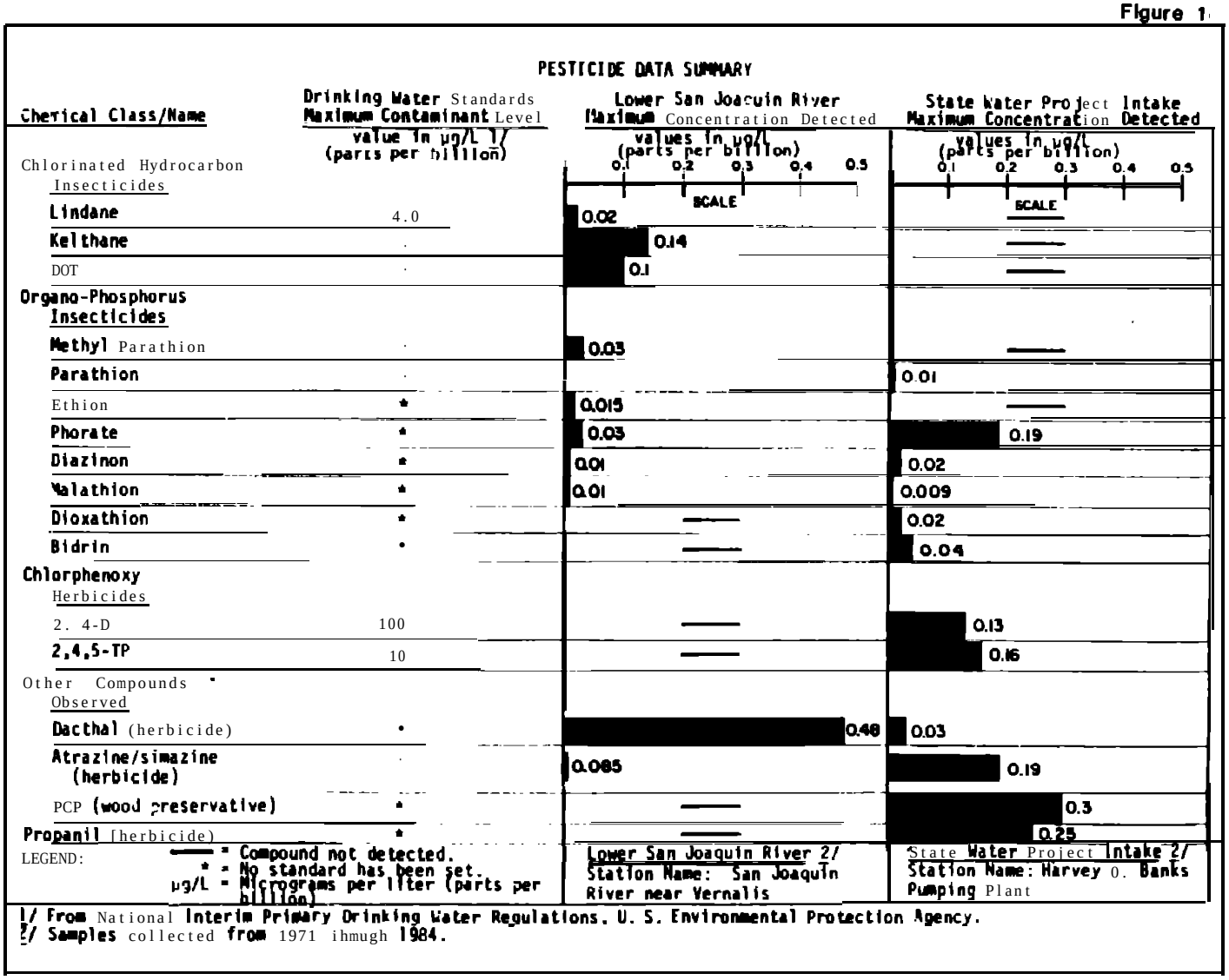
water in O'Neill Forebay, a joint Federal-State facility near Los Banos (refer to Figure 2). From O'Neill Forebay, State Water Project water is transported to municipal water suppliers in Southern California. Based on hourly recordings of electrical conductivity, total salt concentrations of State Water Project deliveries were increased an average of only 3 percent at O'Neill Forebay during the 1974 through 1983 period.

Recently there have been reports that fish taken from the San Joaquin River contain significant levels of pesticides and other toxic pollutants. For the

most part, the chemicals found were residue3 of pesticides such as DDT that were used a number of years ago and that have since been banned. These fat-soluble chemical3 were banned primarily because of their potential for accumulating and concentrating in animal tissues and because they are very slow to degrade in the environment. While these chemicals can present a hazard to animal3 or to consumer3 of the animals, the fat-soluble chemical3 generally are not very water soluble and, therefore, were not found in significant concentrations at sites monitored for this program.

Sample3 collected from the San Joaquin River near Vernalis during 1971 to 1984 indicate concentration3 of pesticides were far below established drinking water limits. Concentration3 of pesticides at the intake to the State Water Project were similarly low. Figure 18 summarizes pesticide data collected from the San Joaquin River and from the intake to the State Water Project, ehowing maximum concentrations of every identified pesticide detected over the years of record. The figure also shows existing drinking water Maximum Contaminant Levels. The data indicate all of the pesticide concentration3 were

Figure 1



below 1 ug/L (one part pesticide per billion parts water).

Concern has recently been expressed that selenium from the San Joaquin Valley may be reaching Delta water supplies in harmful amounts. Panoche Fan has been identified as a major source of selenium in the valley (refer to Figure 2). Data collected since July 1984 for this study are summarized in Table 3 (page 26). Selenium concentrations in the lower San Joequin River and State Water Project intake have not exceeded 1 part per billion, well below the 10 part per billion drinking water limit. Data collected by the U. S. Geological Survey confirm these findings. From October 1977 through September 1982, the USGS collected 19 samples of lower San Joaquin River water. None had selenium levels above 1 part per billion, and 14 of the samples had no detectable selenium /47/.

Agricultural drain water from the Panoche Fan area generally contains concentrations of selenium much higher than the drinking water limit of 10 parts per billion. Concentrations in water of the San Luis Drain average 300 to 400 ug/L /22/. This selenium-laden water flows to Kesterson Reservoir, located north of the town of Los Banos (refer to Figure 2). Although there is no evidence at this time that selenium is reaching the San Joaquin River from Kesterson Reservoir, surveillance should continue.

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Appendix A

MONITORING DATA

STATION DESCRIPTIONS

STATION CODE	STATION NAME	STATION NUMBER
AUERICAN	American River at Water Treatment Plant	A07140.10
CACHE	Cache Slough at Vallejo Pumping Plant	B9D81781448
CLIFTON	Clifton Court at Intake	KAOOOO.OO
COSUMNES	Cosumnes River at Dillard Road	B01175.01
DMC	Delta-Mendota Canal at Intake	B9C74901336
BANKS	Harvey 0. Banks Delta Pumping Plant Headworka	KA0003.31
HONKER	Honker Cut at 8-Mile Road	B9D80361275
DVGH	Lake Del Valle at Glory Hole	DVOO1O.OO
DVSR	Lake Del Valle Stream Release	DV0040.00
LINDSEY	Lindsey Slough at Haetinga Cut	B9D81581462
MALLARD	Mallard Slough at Pumping Plant	B8X80221556
MOKELUHNE	Mokelumne River at Lower Sacramento Road	B02105.20
NOBAY	North Bay Interim Pumping Plant Intake	KEOOOO.OO
ROCKSL	Rock Slough at Old River	B9D75841348
GREENES	Sacramento River at Greene's Landing	B9D82071327
HOOD	Sacramento River at Hood	891780.00
VERNALIS	San Joaquin River near Vernalis	B07020.00
SLDCK2	San Luis Drain at Check 2	BOV71390510
SLDCK17	San Luis Drain at Check 17	BOV65800402
SLDCK41	San Luis Drain at Check 41	BOV64660223
SLDPD5	San Luis Drain at Keateraon Pond No.5	BOV71410533
SLDPC	San Luis Drain Study Bioaaaay Laboratory, Port Chicago	BOV71410533

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

STA. NAME	DATE	TIME (PST)	TEMP (C)	pH	D.O. (<------- mg/L-------)	Na	Cl	Se	EC (uS/cm)
AMERICAN	07/21/83	945	17.0	7.3	10.0	2	1		35
AMERICAN	08/18/83	1400	19.0	7.3	10.1	2	1		36
AMERICAN	09/13/83	1000	19.5	7.2	9.20	2	1		39
AMERICAN	10/04/83	1215	20.0	7.1	9.10	2	1		42
AMERICAN	11/01/83	1205	17.0	7.1	9.00	2	1		40
AMERICAN	12/06/83	1025	11.0	7.2	11.8	2	1		46
AMERICAN	01/10/84	1130	9.00	7.0	11.9	2	1		50
AMERICAN	02/01/84	1220	9.50	7.1	11.9	2	2		53
AMERICAN	03/07/84	1030	9.50	7.3	11.6	2	1		57
AMERICAN	04/04/84	1035	11.0	7.1	11.4	2	1		55
AMERICAN	05/02/84	810	12.5	7.1	11.7	2	1		54
AMERICAN	06/06/84	1045	15.0	7.3	10.3	2	2		52
AMERICAN	07/10/84	950	18.0	7.3	9.40	2	1		48
AMERICAN	08/01/84	1050	19.5	7.2	9.10	2	1		46
AMERICAN	09/05/84	915	22.0	7.2	8.60	2	1		51
AMERICAN	10/04/84	1130	19.5	7.1	9.10	2	1		42
AMERICAN	11/08/84	1120	16.0	7.0	9.30	2	2		51
AMERICAN	12/05/84	1120	11.0	7.3	11.2	2	2		59
CACHE	01/31/84	1045	11.5	8.3	12.4	85	88		976
CACHE	02/22/84	1055	12.5	8.1	10.4	82	82		896
CACHE	03/14/84	1030	16.5	8.1	8.40	79	80		897
CACHE	04/11/84	1005	15.5	8.6	10.1	59	57		720
CACHE	05/23/84	1045	21.0	8.3	9.00	36	34		488
CACHE	06/13/84	815	19.0	8.2	8.50	42	42		595
CACHE	07/11/84	900	24.5	8.3	8.50	36	34		541
CACHE	08/22/84	1040	21.5	8.1	7.50	32	29		495
CACHE	09/12/84	1100	23.0	8.1	8.90	39	38	0.001	577
CACHE	10/11/84	930	19.5	8.2	7.80	44	42		594
CACHE	11/15/84	1000	12.5	7.4	7.70	38	38	0.000	460
CACHE	12/06/84	950	10.5	7.9	8.80	64	64	0.001	744
CLIFTON	07/26/83	1135	21.0	7.3	7.90	20	22		208
CLIFTON	08/23/83	1000	21.5	7.3	7.70	27	31		283
CLIFTON	09/14/83	1035	22.5	7.3	7.80	17	17		180
CLIFTON	10/12/83	910	20.0	7.1	8.30	12	13		137
CLIFTON	11/08/83	945	16.0	7.3	8.50	33	36		324
CLIFTON	12/13/83	1110	12.0	7.1	9.60	16	16		171
CLIFTON	01/24/84	940	10.0	7.3	10.8	22	22		226
CLIFTON	02/28/84	1105	13.0	7.5	10.2	39	42		389
CLIFTON	03/27/84	945	16.5	7.4	9.40	35	40		362
CLIFTON	04/25/84	1040	16.5	7.3	9.30	27	30		288
CLIFTON	05/30/84	820	24.0	7.1	7.40	29	33		307
CLIFTON	06/27/84	945	25.5	7.2	6.30	50	56		472
CLIFTON	07/25/84	940	24.0	7.5	8.60	18	21	0.000	212
CLIFTON	08/29/84	815	24.5	7.3	7.60	20	23		222
CLIFTON	09/27/84	1040	22.0	7.5	8.30	24	24	0.000	261
CLIFTON	10/25/84	1045	17.0	7.5	10.0	27	29		284
CLIFTON	11/29/84	1245	12.0	7.3	10.2	20	21		233
CLIFTON	12/12/84	1055	11.5	7.3	10.0	21	22	0.000	252
COSUMNES	07/21/83	830	22.5	7.3	8.50	3	2		67
COSUMNES	08/18/83	1255	28.0	7.7	8.30	4	2		85
COSUMNES	09/13/83	900	25.0	7.3	7.80	4	2		90
COSUMNES	10/04/83	1105	21.5	7.3	8.90	4	2		80
COSUMNES	11/01/83	1110	18.0	7.3	9.30	4	2		82
COSUMNES	12/06/83	935	8.50	7.2	12.0	7	2		81
COSUMNES	01/10/84	1030	8.00	7.2	11.8	3	2		78
COSUMNES	02/01/84	1115	9.50	7.0	11.5	4	2		93
COSUMNES	03/07/84	935	11.5	7.3	11.4	4	2		86
COSUMNES	04/04/84	940	14.0	7.1	10.7	3	2		80

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

DATE	TURB (TU)	COLOR (CU)	TOC (mg/L)	ASBST (MF/L)	CHCL3	BRCL2	BR2CL	CHBR3	TTHMFP	FLOW (cfs)	GA.HT (ft.)
					(<----------ug/L----------->)						
07/21/83	1	2	1.2		230	3	0	0	230	5000.	
08/18/83	1	2	1.2		210	16	2	0	230	4500.	
09/13/83	2	0	1.0		220	4	0	0	220	4000.	
10/04/83	1	5	1.8	110	160	11	0	0	170	3500.	
11/01/83	2	5	1.2	110	150	4	0	0	150	2500.	
12/06/83	9	12	2.3	1100	270	4	0	0	270	8570.	
01/10/84	10	10	1.1	2200	200	4	0	0	200	8380.	
02/01/84	4	5	1.0	490	200	4	0	0	200	3080.	
03/07/84	3	2	1.3	260	260	17	0	0	280	3980.	
04/04/84	2	2	1.2	190	200	5	0	0	200	4370.	
05/02/84	1	2	1.3	18	160	4	0	0	160	2440.	
06/06/84	3	2	1.0	12	270	10	1	0	280	4070.	
07/10/84	1	0	1.2	18	290	4	0	0	290	4920.	
08/01/84	1	2	1.2		310	4	0	0	310	4890.	
09/05/84	1	2	1.3		320	5	0	0	320	1470.	
10/04/84	2	2	1.2		160	5	0	0	160		
11/08/84	11	15	3.2		280	5	0	0	280		
12/05/84	6	5	1.5		180	4	0	0	180		
01/31/84	13	8	5.5	980	300	85	31	2	420		5.680
02/22/84	76	15	6.4	2500	360	87	26	1	470		5.630
03/14/84	14	15	7.6	650	270	82	27	0	380		6.960
04/11/84	20	10	8.0	1700	500	81	18	0	600		6.390
05/23/84	34	30	6.7	1100	570	63	8	0	640		
06/13/84	52	30	7.0	4000	760	83	8	0	850		
07/11/84	46	25	8.4	1400	800	64	4	0	870		6.410
08/22/84	90	50	7.1		600	51	4	0	660		5.600
09/12/84	20	30	8.4		630	64	5	0	700		3.980
10/11/84	29	25	6.0		850	69	6	0	920		
11/15/84	95	30	9.0		730	47	4	0	780		
12/06/84	50	50	8.5	3200	720	87	10	0	820		
07/26/83	22	8	3.2		310	42	7	0	360	1481.	
08/23/83	20	8	3.1		360	72	12	0	440	2242.	
09/14/83	11	10	3.3		330	23	4	0	360	0.000	
10/12/83	12	12	2.8	530	310	27	2	0	340	0.000	
11/08/83	10	20	3.3	910	270	63	17	0	350	652.0	
12/13/83	13	25	2.9	510	380	30	3	0	410	0.000	
01/24/84	12	25	3.1	510	300	39	6	0	340	0.000	
02/28/84	7	18	3.1	410	280	67	18	0	360	2367.	
03/27/84	10	25	3.8	480	380	79	17	0	480	2453.	
04/25/84	12	15	3.8	890	320	56	13	0	390	4199.	
05/30/84	19	20	4.9	650	420	67	15	0	500	2779.	
06/27/84	28	30	5.4	500	350	110	31	1	490	2995.	
07/25/84	18	25	4.4	960	420	52	8	0	480	4754.	
08/29/84	11	15	3.2		390	54	10	0	450	3827.	
09/27/84	6	15	3.2		390	49	12	0	450	1705.	
10/25/84	7	18	3.4		300	54	14	0	370		
11/29/84	11	30	3.7		460	48	6	0	510		
12/12/84	16	35	4.7		390	52	5	0	450		
07/21/83	1	2	1.0		200	6	0	0	210	257.0	
08/18/83	1	5	1.2		190	9	0	0	200	102.0	
09/13/83	1	2	1.2		210	8	0	0	220	76.00	
10/04/83	2	5	1.2	140	150	6	0	0	160	102.0	
11/01/83	9	8	1.6	180	170	5	0	0	180	378.0	
12/06/83	7	18	2.4	230	830	7	0	0	840	1420.	
01/10/84	4	8	1.0	300	160	4	0	0	160	1230.	
02/01/84	2	5	0.9	18	140	5	0	0	140	561.0	
03/07/84	1	5	1.3	91	190	11	0	0	200	766.0	
04/04/84	1	5	1.6	95	200	9	0	0	210	794.0	

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

STA. NAME	DATE	TIME (PST)	TEMP (C)	pH	D.O. (<-------	Na	Cl	Se mg/L-------->)	EC (uS/cm)
COSUMNES	05/02/84	720	14.0	7.3	10.6	4	1		76
COSUMNES	06/06/84	950	19.0	7.3	9.10	3	2		74
COSUMNES	07/10/84	900	27.5	7.7	7.60	4	2		86
COSUMNES	08/01/84	1003	27.0	7.6	8.10	4	2		93
COSUMNES	09/05/84	820	25.5	7.3	7.10	4	2		96
COSUMNES	10/04/84	1025	21.0	7.4	9.00	4	2		90
COSUMNES	11/08/84	1015	13.5	7.2	10.2	4	2		82
COSUMNES	12/05/84	1040	10.5	7.3	11.3	5	4		129
DMC	07/26/83	1045	23.0	7.3	7.50	33	38		322
DMC	08/23/83	905	21.5	7.3	7.70	28	31		283
DMC	09/14/83	940	21.0	7.3	7.80	18	18		188
DMC	10/12/83	835	18.5	7.3	8.50	14	15		151
DMC	11/08/83	915	16.5	7.2	8.20	37	39		361
DMC	12/13/83	1035	12.0	7.2	9.50	23	26		238
DMC	01/24/84	915	10.5	7.3	10.7	30	33		297
DMC	02/28/84	1025	12.5	7.5	10.0	42	48		397
DMC	03/27/84	915	16.0	7.3	9.50	53	60		511
DMC	04/25/84	955	15.5	7.5	9.30	60	68		552
DMC	05/30/84	750	23.5	7.4	7.60	29	33		298
DMC	06/27/84	905	25.5	7.3	6.00	32	35		328
DMC	07/25/84	910	24.0	7.7	7.40	58	73		554
DMC	08/29/84	740	24.5	7.3	7.30	21	22		229
DMC	09/27/84	1005	22.0	7.4	8.20	28	29	0.000	296
DMC	10/25/84	1000	16.0	7.8	9.80	25	26	0.000	268
DMC	11/29/84	1215	11.0	7.4	10.2	32	34	0.000	321
DMC	12/12/84	1015	11.5	7.2	9.30	31	32	0.000	315
BANKS	03/30/82	900	12.5	7.3	9.70	38	35		315
BANKS	06/29/82	720	20.0	8.0	8.30		41		322
BANKS	08/26/82	905	21.0	7.9	8.30		19		213
BANKS	10/21/82	845	18.5	7.2	8.00		23		212
BANKS	12/29/82	1200	10.0	7.1	9.70		23		225
BANKS	02/24/83	1210	14.0	7.4	9.30		30		288
BANKS	04/27/83	910		7.3	8.40		42		367
BANKS	06/22/83	830	20.5	7.2	8.40		14		143
BANKS	07/26/83	1000	23.0	7.3	8.30	21	22		211
BANKS	08/23/83	830	22.5	7.3	8.00	25	28		261
BANKS	09/14/83	850	22.0	7.3	7.00	22	24		226
BANKS	10/12/83	755	20.5	7.3	7.60	23	26		219
BANKS	11/08/83	850	16.5	7.2	8.60	19	20		186
BANKS	12/13/83	940	12.0	7.3	10.2	32	34		305
BANKS	01/24/84	850	9.50	7.3	11.2	26	28		252
BANKS	02/28/84	940	12.0	7.5	10.0	42	46		388
BANKS	03/27/84	840	16.5	7.3	9.80	36	40		370
BANKS	04/25/84	915	15.0	7.3	9.30	27	30		283
BANKS	05/30/84	725	23.0	7.5	7.10	29	33		304
BANKS	06/27/84	820	24.5	7.3	6.60	24	34		258
BANKS	07/25/84	830	23.0	7.4	8.10	20	23		214
BANKS	08/29/84	715	23.0	7.3	7.40	22	24		244
BANKS	09/27/84	925	22.5	7.3	8.60	25	25	0.000	268
BANKS	10/25/84	920	16.5	7.7	9.30	25	26	0.000	266
BANKS	11/29/84	1130	11.5	7.5	10.5	20	21	0.000	233
BANKS	12/12/84	945	11.5	7.3	10.0	23	24		263
HONKER	02/23/83	1045	13.0	7.3	8.90		27		233
HONKER	04/27/83	1030		7.3	8.80		33		303
HONKER	06/22/83	1000	23.5	7.3	7.60		20		184
HONKER	08/17/83	1000	24.5	7.3	7.10	8	8		126
HONKER	10/04/83	700	20.5	7.3	8.00	7	7		114
HONKER	12/06/83	820	10.0	7.2	10.0	17	26		232

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

DATE	TURB (TU)	COLOR (CU)	TOC (mg/L)	ASBST (MF/L)	CHCL3	BRCL2	BR2CL	CHBR3	TTHMFP	FLOW (cfs)	GA.HT (ft.)
					(<----------ug/L----------->)						
05/02/84	1	2	1.0	25	130	5	0	0	140	597.0	
06/06/84	2	5	1.2	33	230	11	1	0	240	294.0	
07/10/84	2	2	1.6	10	240	9	0	0	250	74.00	
08/01/84	1	10	2.1		320	9	0	0	330	48.00	
09/05/84	1	5	2.0		300	11	0	0	310		
10/04/84	2	2	1.5		160	7	0	0	170		
11/08/84	12	25	2.5		280	6	0	0	290		
12/05/84	2	8	2.2		280	9	0	0	290		
07/26/83	31	5	3.6		290	54	10	0	350	4723.	
08/23/83	22	5	3.2		400	59	9	0	470	3573.	
09/14/83	19	12	2.4		310	26	4	0	340	3245.	
10/12/83	18	12	3.2	760	200	26	2	0	230	2439.	
11/08/83	11	20	3.4	1100	270	48	14	0	330	153.0	
12/13/83	18	35	3.5	570	320	37	6	0	360	3725.	
01/24/84	16	35	3.2	1600	340	52	11	0	400	1198.	
02/28/84	11	18	3.1	370	280	76	25	1	380	4309.	
03/27/84	24	15	3.8	700	270	90	35	2	400	4402.	
04/25/84	18	10	4.7	1800	300	120	45	2	470	4071.	
05/30/84	24	20	4.7	380	380	66	14	0	460	2390.	
06/27/84	30	35	5.0	730	380	70	15	0	460	3313.	
07/25/84	28	15	4.4	1100	450	150	57	4	660	4688.	
08/29/84	16	18	3.7		330	48	9	0	390	3027.	
09/27/84	13	15	3.8		330	55	12	0	400	3150.	
10/25/84	8	20	3.3		360	66	12	0	440		
11/29/84	9	25	4.1		400	64	12	0	480		
12/12/84	18	25	4.9		370	60	8	0	440		
03/30/82	9				930	66	7	0	1000		
06/29/82	11				490	83	14	0	590		
08/26/82	19				430	34	4	0	470		
10/21/82	6				370	45	7	0	420	2779.	
12/29/82	9				630	49	4	0	680	645.0	
02/24/83	10				190	26	4	0	220	6119.	
04/27/83	6				360	69	10	6	440	125.0	
06/22/83	11				350	28	4	0	380	2262.	
07/26/83	17	8	2.8		300	38	6	0	340	1306.	
08/23/83	17	8	3.5		420	58	9	0	490	2179.	
09/14/83	8	20	2.9		330	38	8	0	380	61.00	
10/12/83	6	20	3.1	860	260	47	8	4	320	306.0	
11/08/83	7	25	2.8		310	40	7	0	360	1154.	
12/13/83	13	40	3.3	820	360	42	7	0	410	326.0	
01/24/84	5	20	2.9	490	320	44	8	0	370	267.0	
02/28/84	5	20	3.2		310	75	20	0	400	2563.	
03/27/84	20	30	4.2		460	80	16	0	560	104.0	
04/25/84	37	25	3.9		570	62	12	0	640	3925.	
05/30/84	16	12	4.7		400	72	18	0	490	1865.	
06/27/84	29	40	4.9		410	59	8	0	480	2884.	
07/25/84	16	20	4.7		420	57	9	0	490	4359.	
08/29/84	7	18	3.1		360	55	10	0	420	3438.	
09/27/84	7	15	3.3		370	55	10	0	440	1723.	
10/25/84	8	20	2.9		300	59	9	0	370		
11/29/84	11	30	3.3		430	44	6	0	480		
12/12/84	10	25	4.3		380	50	6	0	440		
02/23/83	13				210	33	6	0	250		6.990
04/27/83	9				300	72	10	5	390		5.460
06/22/83	11				370	43	7	0	420		4.260
08/17/83	6	8	2.5		310	25	5	0	340		4.420
10/04/83	6	12	2.1	190	290	14	1	0	300		5.350
12/06/83	18	60	6.4	620	520	47	7	0	570		6.220

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

STA. NAME	DATE	TIME (PST)	TEMP (C)	pH	D.O. (<-------	Na	Cl	Se -------->)	EC (uS/cm)
HONKER	02/01/84	755	10.0	7.1	9.70	27	32		302
HONKER	04/04/84	815	15.0	7.3	9.60	12	14		171
HONKER	06/06/84	740	19.0	7.5	7.60	13	12		178
HONKER	08/01/84	702	23.0	7.3	7.20	11	12		166
HONKER	10/04/84	750	18.5	7.3	8.80	7	5		120
HONKER	12/05/84	850	10.5	7.2	9.80	12	15		184
DVGH	08/10/83	1200	23.5	8.5	8.40	19	16		466
DVGH	08/10/83	1145	12.5	7.8	3.90	14	11		395
DVSR	09/20/83	720	14.5	7.3	5.30	15	12		414
DVSR	10/18/83	1150	18.0	8.0	7.00	17	13		430
DVSR	11/21/83	1150	15.5	7.9	8.40	18	15		469
LINDSEY	07/11/84	940	24.5	8.4	6.70	37	29		426
LINDSEY	08/22/84	1105	21.5	8.0	7.60	35	26		411
LINDSEY	09/12/84	1155	22.5	7.6	7.00	34	25	0.000	424
LINDSEY	10/11/84	950	19.5	7.8	8.00	32	21		383
LINDSEY	11/15/84	1045	12.5	7.5	8.60	31	23	0.000	353
LINDSEY	12/06/84	1050	11.0	7.3	8.30	44	34	0.000	441
MALLARD	07/28/83	1045	24.2	7.3	8.60	11	11		137
MALLARD	08/25/83	950	21.0	7.6	8.00	21	27		216
MALLARD	09/20/83	900	21.0	7.3	7.70	15	16		181
MALLARD	10/18/83	910	17.5	7.3	8.50	13	13		152
MALLARD	11/21/83	1005	12.5	7.2	9.50	15	16		180
MALLARD	12/28/83	930	10.0	7.3	10.3	13	13		168
MOKELUMNE	07/21/83	715	18.0	7.2	9.60	2	1		34
MOKELUMNE	08/18/83	800	19.0	6.6	9.20	2	1		34
MOKELUMNE	09/13/83	750	19.0	7.1	8.80	2	1		33
MOKELUMNE	10/04/83	815	17.5	6.8	9.50	2	1		32
MOKELUMNE	11/01/83	750	16.5	6.6	8.30	1	1		31
MOKELUMNE	12/06/83	740	12.0	6.8	10.4	2	1		38
MOKELUMNE	01/10/84	925	10.5	6.9	11.0	2	1		42
MOKELUMNE	02/01/84	850	9.50	6.7	11.2	2	1		44
MOKELUMNE	03/07/84	830	11.0	7.2	11.5	2	1		45
MOKELUMNE	04/04/84	735	13.0	7.3	10.9	2	1		47
MOKELUMNE	05/02/84	625	14.0	7.2	10.7	2	1		46
MOKELUMNE	06/06/84	825	15.5	7.3	10.2	2	1		47
MOKELUMNE	07/10/84	755	17.5	7.3	9.50	2	1		48
MOKELUMNE	08/01/84	820	23.5	7.2	9.50	2	1		47
MOKELUMNE	09/05/84	720	18.5	7.3	9.30	2	1		48
MOKELUMNE	10/04/84	915	17.5	7.2	9.40	2	1		44
MOKELUMNE	11/08/84	920	16.0	7.0	9.60	2	1		45
MOKELUMNE	12/05/84	945	12.0	7.2	10.9	2	2		46
NOBAY	07/28/83	830	21.0	7.9	9.00	10	5		301
NOBAY	08/25/83	725	19.0	8.5	8.90	10	5		301
NOBAY	09/20/83	1120	20.0	7.6	9.70	9	5		301
NOBAY	10/18/83	720	17.0	8.9	9.50	10	5		298
NOBAY	11/21/83	845	11.0	7.8	10.4	11	7		312
NOBAY	12/28/83	815	11.5	7.6	10.2	11	6		279
NOBAY	01/31/84	850	11.5	8.2	11.3	12	7		322
NOBAY	02/22/84	925	12.0	8.2	10.7	12	6		314
NOBAY	03/14/84	850	16.0	8.3	8.20	13	6		333
NOBAY	04/11/84	840	15.0	8.4	10.4	10	6		310
NOBAY	05/23/84	925	20.0	8.4	9.30	10	5		312
NOBAY	06/13/84	640	17.5	8.5	9.50	9	5		306
NOBAY	07/11/84	735	19.5	7.5	9.10	9	5		308
NOBAY	08/22/84	917	19.0	8.4	9.20	10	5		314
NOBAY	09/12/84	930	19.5	8.4	9.00	9	5		321
NOBAY	10/11/84	815	18.0	8.2	9.10	9	5		312
NOBAY	11/15/84	845	13.0	8.0	9.40	10	6		296

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

DATE	TURB (TU)	COLOR (CU)	TOC (mg/L)	ASBST (MF/L)	CHCL3 (ug/L)	BRCL2 (ug/L)	BR2CL (ug/L)	CHBR3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)	GA.HT (ft.)
02/01/84	11	25	5.8	380	450	68	10	0	530		
04/04/84	9	12	3.0	500	310	32	4	0	350		5.530
06/06/84	10	10	3.8	260	340	40	7	0	390		5.260
08/01/84	8	15	2.8		460	34	4	0	500		6.540
10/04/84	5	5	1.8		240	14	1	0	260		
12/05/84	13	35	5.0		480	37	4	0	520		
08/10/83	1	5	3.2		310	32	4	0	350	0.000	
08/10/83	3	2	2.9		360	26	2	0	390	0.000	
09/20/83	2	8	2.9		450	16	2	0	470	0.000	
10/18/83	1	8	2.9	54						0.000	
11/21/83	4	15	3.6	310	230	29	4	0	260	0.000	
07/11/84	36	35	6.3	2700	770	57	6	0	830		6.800
08/22/84	65	50	7.1		950	65	4	0	1020		5.870
09/12/84	27	50	7.5		930	59	3	0	990		4.010
10/11/84	28	50	5.6		840	59	4	0	900		
11/15/84	28	25	4.7		570	45	2	0	620		
12/06/84	37	50	9.7	3500	1000	59	2	0	1100		
07/28/83	18	5	3.3		260	26	2	0	290		0.790
08/25/83	19	15	3.4		300	65	13	0	380		
09/20/83	13	15	3.4		410	21	3	0	430		
10/18/83	9	30	3.2	690							1.490
11/21/83	16	40	4.5	1400	170	36	4	0	210		2.540
12/28/83	38	30	3.7	26000	390	30	5	0	430		4.640
07/21/83	3	2	1.4		230	3	0	0	230	1550.	
08/18/83	2	5	1.2		240	8	0	0	250	928.0	
09/13/83	2	2	1.3		250	6	2	0	260	1040.	
10/04/83	2	5	1.4	17	240	4	0	0	240	1210.	
11/01/83	6	8	1.6	31	190	3	0	0	190	1420.	
12/06/83	6	8	4.6	200	190	3	0	0	190	2990.	
01/10/84	9	12	1.8	170	220	3	0	0	220	3790.	
02/01/84	6	10	1.4	32	110	5	0	0	120	1210.	
03/07/84	3	8	1.5	26	260	5	0	0	260	907.0	
04/04/84	2	2	1.5	44	230	5	0	0	240	439.0	
05/02/84	2	5	1.7	10	200	4	0	0	200	270.0	
06/06/84	2	2	1.5	53	230	7	0	0	240	265.0	
07/10/84	1	2	1.6	12	360	5	0	0	360	333.0	
08/01/84	1	0	1.7		310	5	0	0	320	303.0	
09/05/84	1	5	1.5		420	5	0	0	420		
10/04/84	2	2	1.6		290	5	0	0	300		
11/08/84	7	8	2.3		260	4	0	0	260		
12/05/84	4	5	1.8		200	4	0	0	200		
07/28/83	4	5	2.7		290	15	1	0	310	5.000	
08/25/83	4	5	2.7		340	26	2	0	370	5.000	
09/20/83	2	5	3.1		350	9	0	0	360	5.000	
10/18/83	2	12	3.2	200						11.10	
11/21/83	11	25	3.0	1600	280	18	1	0	300	1.000	
12/28/83	22	20	2.6	6000	270	17	5	0	290	1.000	
01/31/84	4	8	2.6	2600	300	18	1	0	320	1.000	
02/22/84	6	8	3.1	2900	290	18	1	0	310	0.500	
03/14/84	4	5	3.0	1500	340	21	1	0	360	0.000	
04/11/84	4	2	2.8	2000	290	18	1	0	310	1.000	
05/23/84	4	5	3.2	370	400	18	1	0	420	1.500	
06/13/84	1	5	2.8	1100	400	18	1	0	420	4.000	
07/11/84	4	5	2.9	1200	340	17	1	0	360	4.500	
08/22/84	8	8	2.8		340	17	1	0	360	5.000	
09/12/84	2	2	3.0		380	20	1	0	400	4.500	
10/11/84	3	5	2.5		470	20	1	0	490		
11/15/84	4	10	2.6		310	15	1	0	330		

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

STA. NAME	DATE	TIME (PST)	TEMP (C)	pH	D.O. (<-------	Na	Cl mg/L------->	Se)	EC (uS/cm)
NOBAY	12/06/84	825	10.5	8.1	10.1	15	10		339
ROCKSL	07/26/83	1240	23.0	7.0	7.00	15	16		158
ROCKSL	08/23/83	1100	24.5	7.2	6.90	15	14		171
ROCKSL	09/14/83	1145	25.0	7.1	6.10	26	29		254
ROCKSL	10/12/83	1005	21.0	7.1	7.70	17	21		177
ROCKSL	11/08/83	1030	17.0	7.2	8.40	22	23		224
ROCKSL	12/13/83	1220	12.0	6.9	9.80	20	21		202
ROCKSL	01/24/84	1025	10.0	7.3	10.8	25	25		248
ROCKSL	02/28/84	1205	13.5	7.5	10.0	32	35		316
ROCKSL	03/27/84	1030	16.5	7.5	9.80	22	24		254
ROCKSL	04/25/84	1135	16.5	7.3	9.60	15	14		193
ROCKSL	05/30/84	905	24.0	7.5	8.10	15	15		194
ROCKSL	06/27/84	1050	26.0	7.2	6.80	16	15		189
ROCKSL	07/25/84	1045	24.0	7.7	8.10	22	27		217
ROCKSL	08/29/84	900	24.0	7.4	8.20	21	26		221
ROCKSL	09/27/84	1130	23.0	7.8	8.30	16	14		199
ROCKSL	10/25/84	1130	17.0	8.0	10.9	16	15		194
ROCKSL	11/29/84	1330	12.0	7.4	10.5	14	13		186
ROCKSL	12/12/84	1145	11.0	7.3	9.70	14	13		195
GREENES	07/21/83	600	19.5	7.3	8.70	7	4		115
GREENES	08/18/83	645	21.0	7.5	8.20	7	4		124
GREENES	09/13/83	640	20.5	7.3	8.30	10	6		154
GREENES	10/04/83	925	18.0	7.3	9.00	7	5		124
GREENES	11/01/83	650	17.0	7.3	9.10	8	5		128
GREENES	12/06/83	635	10.5	7.4	10.6	4	4		122
GREENES	01/10/84	815	9.00	7.3	10.7	7	4		129
GREENES	02/01/84	950	10.0	7.1	10.8	7	5		140
GREENES	03/07/84	735	12.0	7.5	10.8	10	7		164
GREENES	04/04/84	635	13.5	7.5	10.4	9	6		148
GREENES	05/02/84	530	16.0	7.3	9.40	10	6		154
GREENES	06/06/84	625	18.0	7.5	8.70	10	7		146
GREENES	07/10/84	650	22.5	7.4	8.20	7	4		121
GREENES	08/01/84	600	21.5	7.4	7.90	8	4		133
GREENES	08/21/84	1040	23.0	7.3	8.20	11	6		164
GREENES	09/05/84	605	22.0	7.4	7.70	12	6	0.000	185
GREENES	10/04/84	620	17.5	7.4	9.00	8	4	0.000	132
GREENES	11/08/84	820	14.0	7.3	9.70	10	6	0.000	154
GREENES	12/05/84	745	10.5	7.4	10.9	9	6	0.000	160
HOOD	03/30/82	1050	11.0	7.3	10.7		4		131
HOOD	06/29/82	905	20.0	7.9	8.50		5		128
HOOD	08/26/82	1100	22.0	7.5	8.10		5		149
HOOD	10/21/82	1150	18.0	7.5	8.70		4		122
HOOD	12/29/82	1400	9.50	7.2	10.9		4		130
HOOD	02/24/83	1410	12.0	7.5	10.6		2		113
HOOD	04/27/83	540		7.3	10.0		3		112
HOOD	06/22/83	1100	19.5	7.3	9.10		3		101
VERNALIS	03/30/82	715	10.5	7.3	9.90		36		341
VERNALIS	06/29/82	530	18.0	7.7	8.40		30		267
VERNALIS	08/26/82	710	21.0	7.7	7.30		50		392
VERNALIS	10/21/82	715	16.0	7.3	9.00		17		166
VERNALIS	12/29/82	800	9.00	7.0	9.30		12		152
VERNALIS	02/24/83	1040	13.0	7.5	9.60		26		264
VERNALIS	04/27/83	740		7.1	9.70		11		150
VERNALIS	06/22/83	630	21.0	7.0	8.50		10		117
VERNALIS	07/26/83	815	20.0	7.3	7.70	29	30		288
VERNALIS	08/23/83	700	20.0	7.2	8.00	23	24		247
VERNALIS	09/14/83	715	20.0	7.4	8.20	15	14		158
VERNALIS	10/12/83	625	17.5	7.1	8.50	11	11		126

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

DATE	TURB (TU)	COLOR (CU)	TOC (mg/L)	ASBST (MF/L)	CHCL3 (ug/L)	BRCL2 (ug/L)	BR2CL (ug/L)	CHBR3 (ug/L)	TTHMFP (ug/L)	FLOW (cfs)	GA.HT (ft.)
12/06/84	12	18	3.6	1600	400	23	1	0	420		
07/26/83	16	8	3.4		310	34	5	0	350		
08/23/83	17	8	2.6		440	35	4	0	480		
09/14/83	15	35	4.6		440	43	9	0	490		4.810
10/12/83	11	20	2.8	950	270	39	6	6	320		4.200
11/08/83	10	25	3.5	570	260	37	7	0	300		4.450
12/13/83	11	30	3.0	560	270	36	4	0	310		
01/24/84	16	35	3.3	500	320	42	8	0	370		
02/28/84	11	30	3.6	500	340	65	12	0	420		
03/27/84	17	30	3.2	480	370	54	8	0	430		
04/25/84	14	15	3.4	1100	310	31	4	0	340		
05/30/84	16	12	3.8	140	360	39	5	0	400		
06/27/84	12	30	3.5	430	380	39	4	0	420		2.690
07/25/84	10	15	2.5	600	320	63	17	0	400		4.320
08/29/84	5	12	2.6		310	60	16	0	390		5.430
09/27/84	9	10	2.8		310	31	3	0	340		3.810
10/25/84	8	12	3.2		330	32	4	0	370		
11/29/84	10	30	3.7		580	32	2	0	610		
12/12/84	11	30	4.4		410	31	2	0	440		
07/21/83	9	2	1.6		190	8	1	0	200	.26E5	
08/18/83	8	8	1.6		200	14	1	0	220	.25E5	
09/13/83	12	8	1.8		600	18	2	0	620	.23E5	
10/04/83	10	5	1.6	380	200	9	0	0	210	.25E5	
11/01/83	6	5	1.7	340	210	8	0	0	220	.18E5	
12/06/83	30	30	4.1	2200	300	9	0	0	310	.66E5	
01/10/84	19	20	1.7	3200	220	10	1	0	230	.67E5	
02/01/84	14	12	1.5	740	190	11	1	0	200	.32E5	
03/07/84	8	8	1.6	540	230	28	1	0	260	.26E5	
04/04/84	8	5	1.6	680	250	14	1	0	260	.25E5	
05/02/84	8	8	2.0	110	180	13	1	0	190	.11E5	
06/06/84	9	8	2.0	200	250	15	1	0	270	.14E5	
07/10/84	11	5	1.6	150	260	10	0	0	270	.21E5	
08/01/84	11	5	1.6		300	10	1	0	310	.22E5	
08/21/84	12	10	1.8		250	16	1	0	270	.18E5	
09/05/84	11	8	2.4		390	20	1	0	410		
10/04/84	7	5	1.6		170	13	1	0	180		
11/08/84	11	8	2.1		210	11	0	0	220		
12/05/84	24	15	2.6		240	14	1	0	260		
03/30/82	20	5			310	9	0	0	320	.40E5	
06/29/82	6				230	12	0	0	240	.20E5	
08/26/82	10				280	13	0	0	290	.23E5	
10/21/82	4				260	10	0	0	270	.16E5	
12/29/82	33				480	16	1	0	500	.72E5	
02/24/83	30				120	4	0	0	120	.74E5	
04/27/83	26				166	6	4	4	180	.55E5	
06/22/83	17				200	8	0	0	210	.44E5	
03/30/82	14	13			1400	67	9	0	1500	9720.	
06/29/82	15				470	93	12	0	580	7400.	
08/26/82	22				390	71	19	0	480	3750.	
10/21/82	8				330	37	0	0	370	7420.	
12/29/82	28				770	37	0	0	810	.22E5	
02/24/83	18				190	24	4	0	220	.29E5	
04/27/83	12				310	20	6	5	340	.37E5	
06/22/83	23				380	23	2	0	400	.24E5	
07/26/83	29	5	3.5		290	54	12	0	360	.11E5	
08/23/83	19	5	3.0		420	39	7	0	470	9170.	
09/14/83	16	10	2.8		350	21	3	0	370	.11E5	
10/12/83	12	10	2.8	780	270	24	3	0	300	.15E5	

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

STA. NAME	DATE	TIME (PST)	TEMP (C)	pH	D.O. (<-------	Na	Cl mg/L------->	Se)	EC (uS/cm)
VERNALIS	11/08/83	730	15.0	7.3	8.20	39	38		381
VERNALIS	12/13/83	825	11.0	7.1	10.0	14	13		155
VERNALIS	01/24/84	735	10.0	7.0	10.0	21	19		210
VERNALIS	02/28/84	815	12.0	7.5	9.70	38	39		352
VERNALIS	03/27/84	720	14.5	7.3	9.40	48	52		464
VERNALIS	04/25/84	755	14.0	7.3	8.80	59	66		547
VERNALIS	05/30/84	620	24.5	7.9	7.30	69	80		629
VERNALIS	06/27/84	650	25.5	7.3	6.30	77	88		694
VERNALIS	07/25/84	705	23.0	7.5	6.50		92	0.001	640
VERNALIS	08/29/84	620	24.0	7.6	7.10	58	62		549
VERNALIS	09/27/84	725	20.0	7.4	8.30	39	43	0.000	388
VERNALIS	10/25/84	810	15.5	7.4	7.90	39	41	0.000	378
VERNALIS	11/29/84	940	11.5	7.1	9.20	43	44	0.000	400
VERNALIS	12/12/84	830	11.0	7.3	9.20	34	32	0.000	324
SLDCK2	07/20/83	1125	25.0	8.6	9.00	2420	1760		12600
SLDCK2	08/17/83	650	28.0	7.9	8.00	2120	1640		11600
SLDCK2	09/06/83	915	26.5	7.8	8.00	2220	1660		11900
SLDCK2	10/06/83	815	21.5	8.4	8.30	2200	1610		11900
SLDCK2	11/15/83	1425	15.5	8.8	13.0	2140	1470		11300
SLDCK2	12/20/83	1110	13.5	8.2	10.3	2120	1380		10500
SLDCK17	07/20/83	915	23.5	8.5	9.00	2130	1590		11500
SLDCK17	08/16/83	1240	30.5	7.9	9.40	2120	1580		11500
SLDCK17	09/06/83	800	25.5	7.9	8.00	2180	1560		11700
SLDCK17	10/05/83	1340	23.0	8.6	12.5	2160	1600		11800
SLDCK17	11/15/83	1330	16.5	8.6	11.5	2300	1440		11700
SLDCK41	07/20/83	805	21.5	8.3	9.50	1970	1500		11000
SLDCK41	08/16/83	1130	25.0	7.6	7.50	2020	1540		11100
SLDCK41	09/06/83	700	23.5	7.9	11.6	2070	1560		11400
SLDCK41	10/05/83	1245	22.0	8.3	7.70	2040	1600		11400
SLDCK41	11/15/83	1240	16.5	8.6	15.5	2700	1580		13400
SLDCK41	12/20/83	955	15.0	8.1	10.8	1760	1340		9320
SLDPD5	07/20/83	1210	22.0	8.6	4.00	2940	2160		14700
SLDPD5	08/17/83	715	25.0	7.5	1.40	2980	2250		15200
SLDPD5	09/06/83	950	24.0	7.5	1.50	2540	1960		13600
SLDPD5	10/06/83	855	20.0	7.7	3.30	2300	1780		12500
SLDPD5	11/15/83	1455	13.0	8.6	10.8	2120	1520		11200
SLDPD5	12/20/83	1135	13.0	8.0	8.70	2020	1390		10200
SLDPC	07/28/83	945	23.0	7.5	8.40	944	865		5890
SLDPC	08/25/83	845	20.0	8.1	8.80	940	860		5900
SLDPC	09/20/83	1000	22.5	7.6	8.50	1120	1010		6910

APPENDIX TABLE A
INTERAGENCY DELTA HEALTH ASPECTS MONITORING PROGRAM DATA

DATE	TURB (TU)	COLOR (CU)	TOC (mg/L)	ASBST (MF/L)	CHCL3 (<----------ug/L----------->)	BRCL2	BR2CL	CHBR3	TTHMFP	FLOW (cfs)	GA.HT (ft.)
11/08/83	18	25	4.2	1300	300	62	12	0	370	9370.	
12/13/83	14	30	3.2	740	330	22	2	0	350	.22E5	
01/24/84	14	25	3.1	870	340	32	4	0	380	.21E5	
02/28/84	10	15	3.2	270	250	60	15	0	320	9640.	
03/27/84	34	15	3.9	1800	280	86	23	2	390	6300.	
04/25/84	24	8	4.8	1700	290	110	42	2	440	3980.	
05/30/84	75	10	6.1	1300	380	120	56	3	560	2440.	
06/27/84	50	25	5.8	1300	360	130	58	3	550	2050.	
07/25/84		15	5.4	3300	450	150	72	7	680	1840.	
08/29/84	24	20	4.8		350	110	48	2	510	2520.	
09/27/84	17	10	4.2		280	79	21	0	380		
10/25/84	15	12	3.9		260	64	23	1	350		
11/29/84	10	25	4.4		380	68	15	0	460		
12/12/84	6	12	3.6		240	50	12	0	300		
07/20/83	1	5	9.2		19	140	500	550	1200	11.60	
08/17/83	1	8	9.3		26	110	420	280	840	9.650	
09/06/83	1	10	9.5		67	340	720	380	1500	8.820	
10/06/83	2	25	28.		36	260	710	630	1600	7.370	
11/15/83	6	45	30.		39	280	710	680	1700	8.490	
12/20/83	1	18	7.5		42	190	410	330	970	15.50	
07/20/83	1	5	9.5		34	160	520	610	1300	11.60	
08/16/83	2	8	10.		30	140	750	340	1300	10.30	
09/06/83	5	12	18.		70	310	600	470	1400	9.480	
10/05/83	2	30	29.		31	210	750	680	1700		
11/15/83	3	25	19.		35	230	580	710	1600	6.910	
07/20/83	1	5	7.3		37	150	480	540	1200	11.60	
08/16/83	4	8	10.		18	130	420	250	820	9.480	
09/06/83	3	15	11.		100	330	350	180	960	9.150	
10/05/83	1	15	13.		30	160	370	280	840	7.530	
11/15/83	4	25	21.		25	200	480	230	930	6.910	
12/20/83	2	8	9.8		32	140	310	230	710	13.60	
07/20/83	0	12	11.		21	180	780	950	1900	0.000	
08/17/83	1	12	11.		20	190	720	520	1400	0.000	
09/06/83	0	8	8.7		76	340	750	490	1700	0.000	
10/06/83	0	25	11.		58	270	660	1300	2300	0.000	
11/15/83	2	35	26.		59	320	750	960	2100	0.000	
12/20/83	1	20	11.		63	220	470	380	1100	0.000	
07/28/83	3	2	4.2		36	120	190	140	490	0.000	
08/25/83	3	5	4.0		42	170	260	140	610	0.000	
09/20/83	96	5	4.3		38	110	290	160	600	0.000	

Appendix B

DETAILS OF ANALYTICAL QUALITY CONTROL PROCEDURES

McKESSON ENVIRONMENTAL SERVICES LABORATORY

McKesson Environmental Services
6363 Clark Avenue. P O. Box 2277. Dublin CA 94568 Tel 415 828 14[illegible]
Outside California 800 227 1316

McKesson

LIMITS OF DETECTION

Pollution of Delta waters by industrial or agricultural chemicals can occur from both point sources and non-point sources. In either case, the high degree of dilution afforded by the high volume of run-off water entering the Delta is expected to result in very low concentrations of synthetic organic chemicals in Delta waters. These expected low concentrations challenge the analytical methodologies available for the detection and measurement of compounds of interest.

For the present program, primary emphasis has been placed on analysis for the EPA "Priority Pollutants." For this purpose we have used the following EPA Test Methods:

Method 624 - Purgeables
Method 601 - Purgeable Halocarbons
Method 625 - Base/Neutrals and Acids
Method 608 - Organochlorine Pesticides and PCBs.

When certain non-priority pollutant compounds have been determined, other EPA methods were employed; for example, Method 614 - Organophosphorous Pesticides.

Each of the EPA methods includes values for method detection limits for many of the compounds covered by the specific method. The GC/MS methods (624 and 625) are the methods of choice for an initial survey, since the mass spectrometer is a universal detector which also provides positive identification of the analyte. However, the sensitivity of this detector is such that the method detection limit is generally higher than the expected level of those organic pollutants in Delta waters. Consequently, some procedural modifications have been used and some additional analyses using more sensitive detectors have been completed.

For purgeable priority pollutants, the initial analysis was by Method 624, for which method detection limits of 1 - 10 µg/L are reported. This was supplemented by use of Method 601, for which detection limits of 0.1 - 1 µg/L can be achieved. This latter method uses a halogen specific detector of high sensitivity.

For extractable organics, Method 625 offers detection limits in the range of 2 to 20 µg/L. In order to improve on this, the procedure has been modified slightly to increase the concentration factor by x10 and consequently to lower the detection limit by a factor of 10. This was achieved by increasing the sample volume to 2 liters (from 1 liter) and concentrating the extract to 0.2 ml (instead of 1 ml).

A similar treatment of sample extraction has been used with Method 608 and Method 614. These methods employ highly sensitive detectors, with very low reported method detection limits (0.002 µg/L for dieldrin and 0.012 µg/L for diazinon, for example).

The method detection limits (MDL) as quoted above may be considerably lower than the actual limit of detection (LOD) for any real sample since the MDL is determined without consideration of matrix interferences, sample blanks, etc. For the present project, matrix interferences are the limiting factor, restricting the amount by which the LOD can be lowered by increasing the concentration factor. Values quoted for LOD in this report (for non-GC/MS methods) are analysts' estimates of analyte concentrations needed for determination of that analyte above the matrix interference level.

QUALITY CONTROL / QUALITY ASSURANCE

McKesson Environmental Services laboratories operate under a thorough program of quality assurance/ quality control,

Sample Receipt, Handling, Storage and Control

When a sample arives from the field, the sample custodian performs the following functions:

- Receipt of sample is recorded.
- Package is inspected and any damage recorded.
- Package contents are verified.
- Chain-of-Custody document is completed and discrepancies reported.
- Sample is logged in, number assigned and sample tagged.
- Laboratory sample sheet is initiated.
- Sample is assigned to storage.

Security, Chain-of-Custody and Document Control

In order to maintain a clear record for sample traceability and document accountability, the following procedures are enforced:

- Environmental Services laboratories and sample storage areas are maintained as secure facilities at all times.
- Chain-of-Custody procedures are rigorously followed.
- A document control officer is appointed.
- Documents are numbered and a document inventory maintained to include log books, sample sheets, and quality assurance documents.

Laboratory Operations

The laboratory performs adequate quality control on samples to assure the precision and accurancy of the data. The following are the minimum quality control requirements:

- One sample analyzed in duplicate for every ten samples or batch of samples.
- One spiked sample for every ten samples or batch of samples. Spikes shall be made at two to three times the detection limit, or at the analyte level.
- Surrogate compounds for volatile organic, base/neutral, and acid extractables.
- Method and field blanks, as apropriate, especially for aqueous samples.

For the present program, Methods 601, 624 and 625 employ surrogate spike compounds with the analysis of each sample, An internal standard is used with each sample for Method 608 and individual compound recoveries have been determined for typical compounds covered by other methods used.

DEPARTMENT OF WATER RESOURCES BRYTE LABORATORY

QUALITY CONTROL PROCEDURES

DEPARTMENT OF WATER RESOURCES BRYTE LABORATORY

1. Laboratory blanks are run on each analytical day.

2. Travel blanks are run along with each group of samples.

3. Standards are run at the beginning and end of each group of analyses.

4. Sample aliquot volumes are adjusted so standards bracket concentration of analyte, or are within 10 per cent of sample peak height for each compound being analyzed.

LIMITS OF DETECTION

DEPARTMENT OF WATER RESOURCES BRYTE LABORATORY

Compound	Detection Limit (ug/L)
chloroform	0.1
bromodichloromethane	0.1
dibromochloromethane	0.2
bromoform	0.5
Alachlor	0.01
Atrazine	0.01
Azinphosmethyl (Guthion)	0.01
Bentazon	---
Chlorothalonil	0.01
2,4-D, Alkanolamine Salts	0.01
D-D Mixture	0.1
DEF	0.01
Diazinon	0.01
2,6-Dichloro-4-Nitroaniline	0.01
Dicofol	0.01
Dimethoate	0.01
Dimethyl Tetrachloroterephthalate (Dacthal)	0.01
DNBP (Dinoseb)	0.01
Disulfoton	0.01
Diuron	0.01
Ethylene Dibromide	0.2
Malathion	0.01
Methyl Bromide	0.1
Methyl Parathion	0.01
Parathion	0.01
Simazine	0.01
Toxaphene	0.5
Trifluralin	--
Xylene	4

GAS CHROMATOGRAPHIC CONDITIONS EMPLOYED FOR VOLATILE HALOCARBON ANALYSES

Gas Chromatograph: Tracor 565

Detectors: Hall 700A Electrolytic Conductivity Detector
Tracor 703 Photoionization Detector

Column: 6' glass tube, 2 mm I.D.

Column Packing: 1% SP-1000 on Carbopack B 60/80 mesh (Supelco, Inc.)
Confirmation: n-octane on Porisil-C 100/120 mesh (Supelco, Inc.)

Temperatures: Injector: 200 deg. C

Column: 1% SP-1000; 100 deg.C - 3 min., 8 deg.C./min. to 220 deg.C.,hold 4 min.

n-octane; 60 deg. C.-4 min, 6 deg.C/min to 170 deg.C, hold 4 min.

Carrier Gas: He; Flow 30 ml/min.

Reaction Gas: H2; Flow 30 ml/min.

Recorder Chart Speed: 13 mm/min.

Sampler: 5 ml- Tekmar Liquid Sample Concentrator, Model LSC-2, with modified ALS Automated Sampler. Purge 11 min.; Desorb 4 min.; Bake 10 min.

Trap: As specified in EPA Method 601 1/

Approximate Retention Time (min.): 2/

	n-octane	SP-1000
Chloroform	7.0	7.4
Bromodichloromethane	9.8	10.4
Dibromochloromethane	12.4	13.6
Bromoform	15.0	16.6

1/ Reference: Federal Register. 44:233 - Purgeable Halocarbons Method 601

2/ Standards: Trihalomethane Mixture 4-8746. Supelco, Inc., Bellefonte, PA 16823

ANALYSIS OF TRIHALOMETHANE REFERENCE SAMPLE
March 1982

Organization	Trihalomethane Concentration (ug/L) CHCl3	CHBrCl2	CHBr2Cl	CHBr3	Total
Department of Water Resources Bryte Laboratory	3.1	3.3	8.6	36	51
Department of Health Services Sanitary and Radiation Laboratory	2.8	2.8	6.4	31.7	43.7